INDEXED

Marine Engineering

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DEC 15 1902

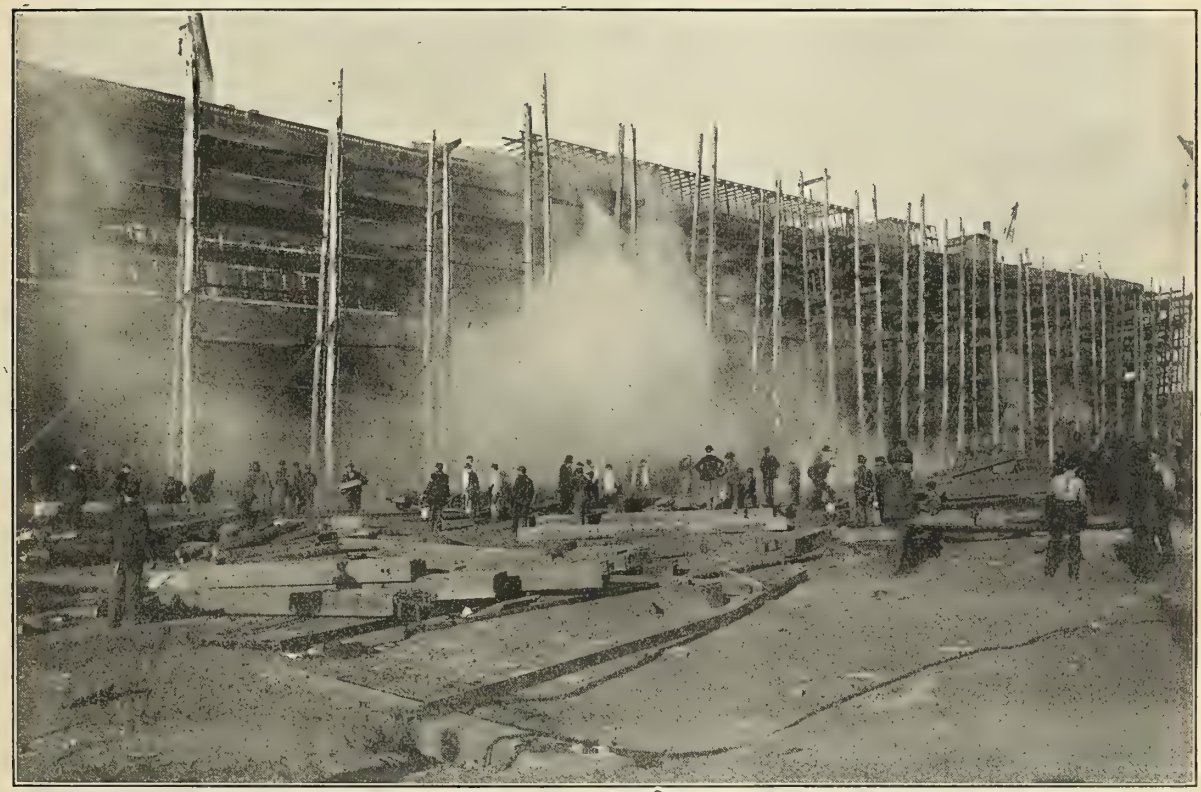
BURNING OF THE STEAMSHIP "MISSOURI."

The most serious fire in the history of shipbuilding, and one believed to be without a parallel, damaged the new steamer *Missouri*, building for the Atlantic Transport Company at the yards of the Maryland Steel Company, Sparrows Point, Maryland, during the afternoon of October 22, 1902. The ship was about ready to launch, the ways being greased, and the ship carpenters were engaged in replacing packing, etc.

The origin of the fire is unknown, not one of the 500 or more men employed around the slips seeing any indications of a conflagration until it was well under way.

Starting about the middle of the length on the port side, the fire quickly spread along the ways and through the staging and poles, and in less than five minutes from the sounding of an alarm the entire middle portion was a mass of flames. The fire department was promptly on hand and did all in its power to stay the spreading of the flames, but was unsuccessful, and until the arrival of several tugs from Baltimore the ship seemed doomed. The ways and shores on the port side for a distance of over 300 feet amidships gradually burned through, causing the ship to settle and heel to port, and for a time it appeared as though the ship would fall to the ground on her side. The keel blocks at the ends, which were the only ones now supporting the ship, were crushed into kindling-wood because of the great weight. Fortunately, however, the launching ways formed a resting place and held her at a list of about two feet.

The appearance of the ship during and after the fire can be seen from the illustrations. It is impossible at this time to determine the amount of damage sustained. The entire middle portion was surrounded by flames for an hour and a half, and the plates are now badly bent and distorted by the tremendous heat.



THE BURNING WAYS OF THE STEAMSHIP MISSOURI AT THE MARYLAND STEEL COMPANY.

The *Maine*, a sister ship, is building on the next ways, and every effort was made to prevent the spreading of the flames to her slip. Beyond a few charred shores and the staging and poles, no damage was done.

The problem which now presents itself to the builders is to right the steamer and raise her enough to launch,

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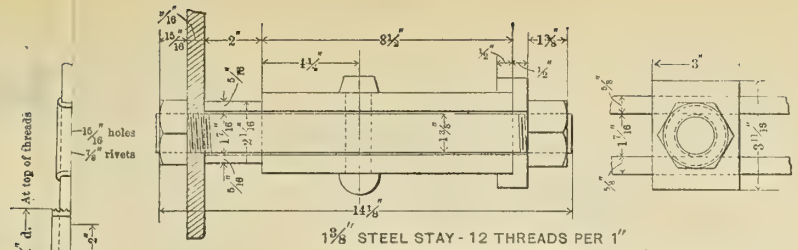
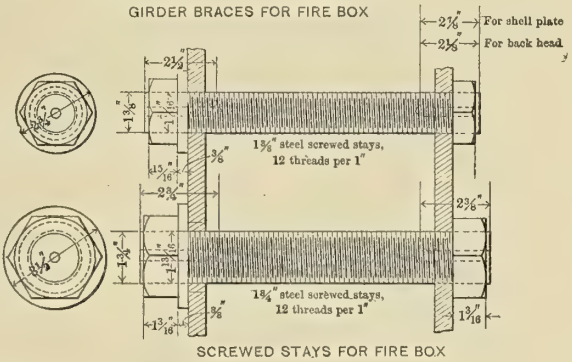
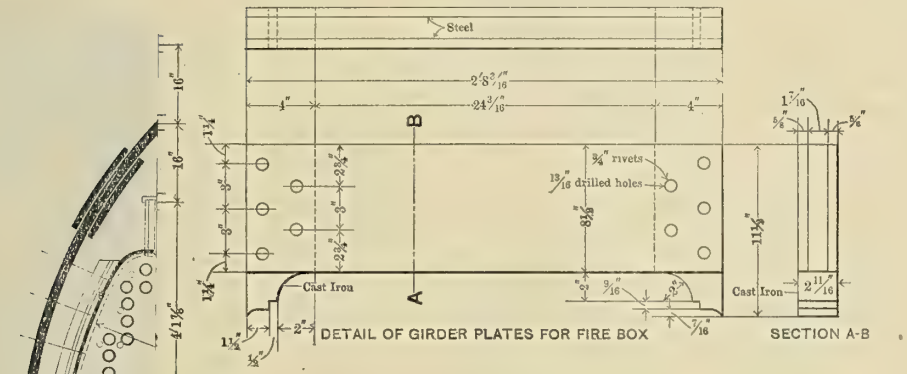


1⅜″ STEEL STAY - 12 THREADS PER 1″
GIRDER BRACES FOR FIRE BOX

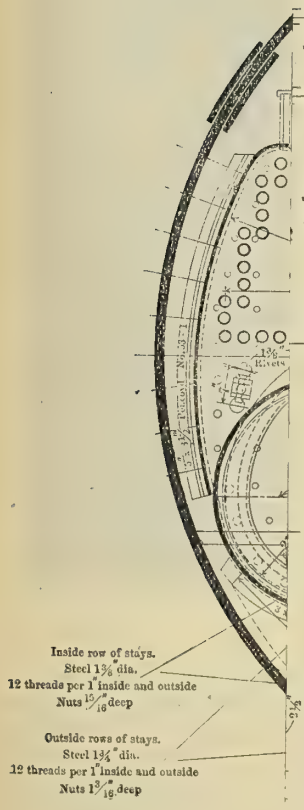


SCREWED STAYS FOR FIRE BOX



DETAIL OF GIRDER PLATES FOR FIRE BOX

SECTION A-B

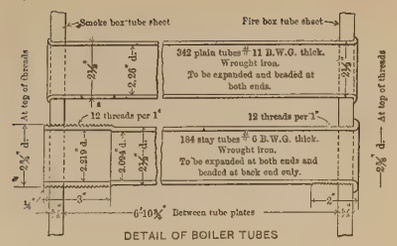


Inside row of stays.
Steel 1¾″ dia.
12 threads per 1″ inside and outside
Nuts 15/16″ deep

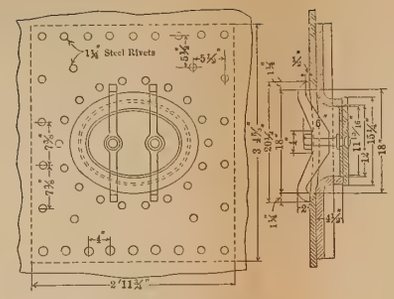
Outside rows of stays.
Steel 1¾″ dia.
12 threads per 1″ inside and outside
Nuts 1 3/16″ deep

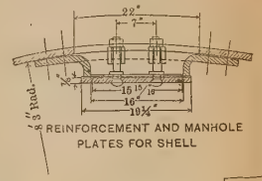
BOILER DATA.

Dia. inside		16′6″
Length		10′5″
Pressure		160 lbs.
Heating Surface	Tubes	2373.2
	Furnaces	168.5
	Combs. Chamber	226.3
Total, 1 boiler		2768 sq′
Grate surface		83 sq′
Ratio H.S. to G.S.		31.4
No. of plain tubes # 11 B.W.G.		342
" " stay " # 6 "		184
Total		526

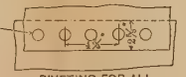

Smoke box tube sheet
Fire box tube sheet
342 plain tubes # 11 B.W.G. thick. Wrought iron. To be expanded and beaded at both ends.
12 threads per 1"
184 stay tubes # 6 B.W.G. thick. Wrought iron. To be expanded at both ends and beaded at back end only.
At top of threads
6'10¾" Between tube plates

DETAIL OF BOILER TUBES

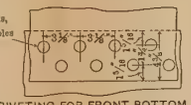




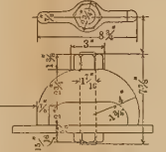
REINFORCEMENT AND MANHOLE PLATES FOR SHELL



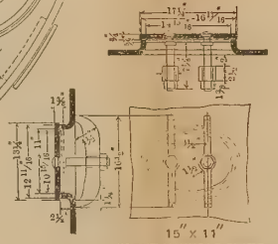
RIVETING FOR ALL SINGLE RIVETED JOINTS



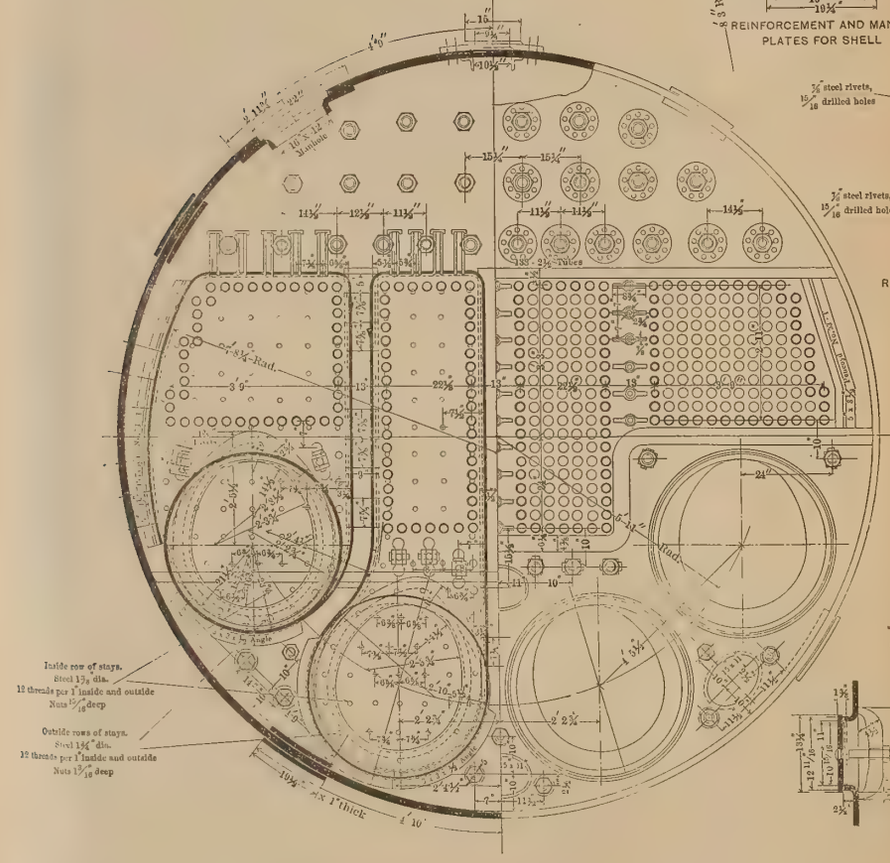
RIVETING FOR FRONT BOTTOM LAP

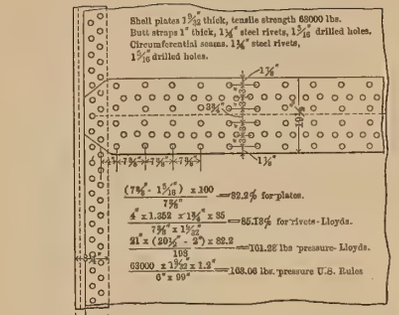


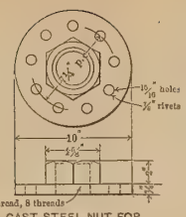
DOGS FOR TUBE SHEET



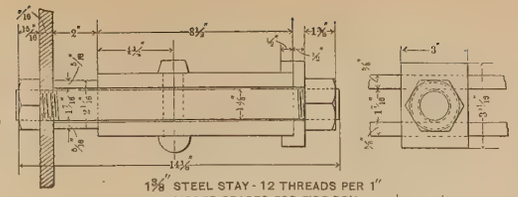
FRONT MANHOLE PLATE


16" x 12" Manhole
8" Rad.
3'9" Rad.
Inside row of stays. Steel 1⅜" dia. 12 threads per 1" inside and outside Nuts 5/16" deep
Outside rows of stays. Steel 1⅜" dia. 12 threads per 1" inside and outside Nuts 13/16" deep
10¾" x 1" thick
4'10"

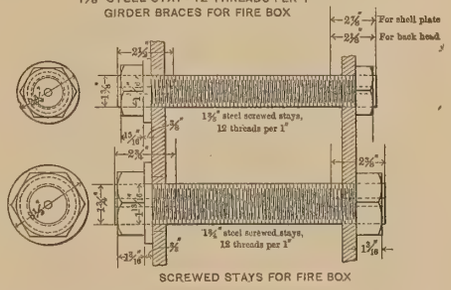

Shell plates 1 29/32" thick, tensile strength 60000 lbs.
Butt straps 1" thick, 1¼" steel rivets, 1 5/16" drilled holes.
Circumferential seams, 1¼" steel rivets, 1 5/16" drilled holes.
(7⅛" - 1 5/16") / 7⅛" x 100 = 82.2% for plates.
⅞" x 1.352 x 1¼" x 35 / 7⅛" x 1 29/32" = 85.13% for rivets - Lloyds.
21" x (10¾" - 2") x 82.2 / 103 = 101.28 lbs pressure - Lloyds.
63000 x 1 29/32 x 1.2" / 6" x 99" = 168.06 lbs. pressure U.S. Rules



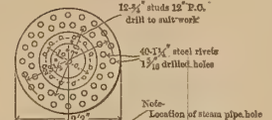
CAST STEEL NUT FOR THROUGH STAYS

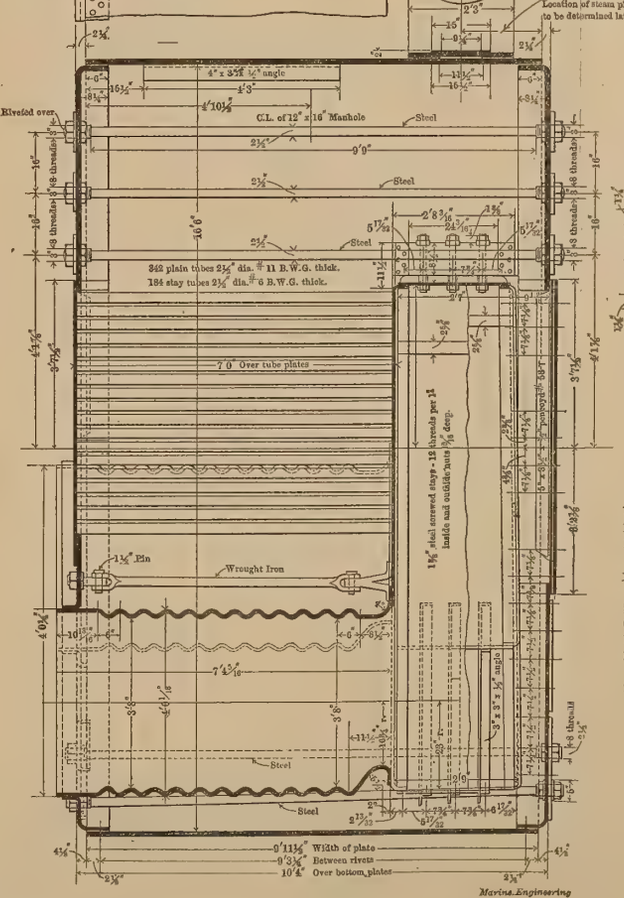


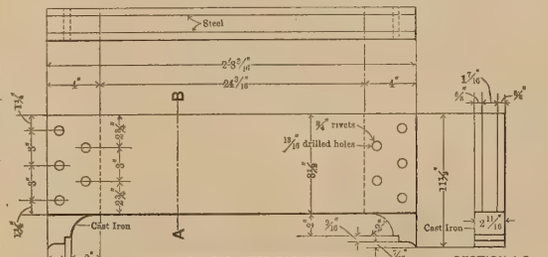
1⅜" STEEL STAY - 12 THREADS PER 1" GIRDER BRACES FOR FIRE BOX



SCREWED STAYS FOR FIRE BOX




Note- Location of steam pipe hole to be determined later.
Riveted over
4" x 3½" x ½" angle
C.L. of 12" x 16" Manhole
Steel
342 plain tubes 2¼" dia. # 11 B.W.G. thick.
184 stay tubes 2¼" dia. # 6 B.W.G. thick.
7'0" Over tube plates
1¼" Pin
Wrought Iron
1¾" steel screwed stays - 12 threads per 1" Inside and outside nuts ⅝ deep.
3" x 3" x ½" angle
9'11⅛" Width of plate
9'3⅛" Between rivets
10'4" Over bottom plates



DETAIL OF GIRDER PLATES FOR FIRE BOX

SECTION A-B

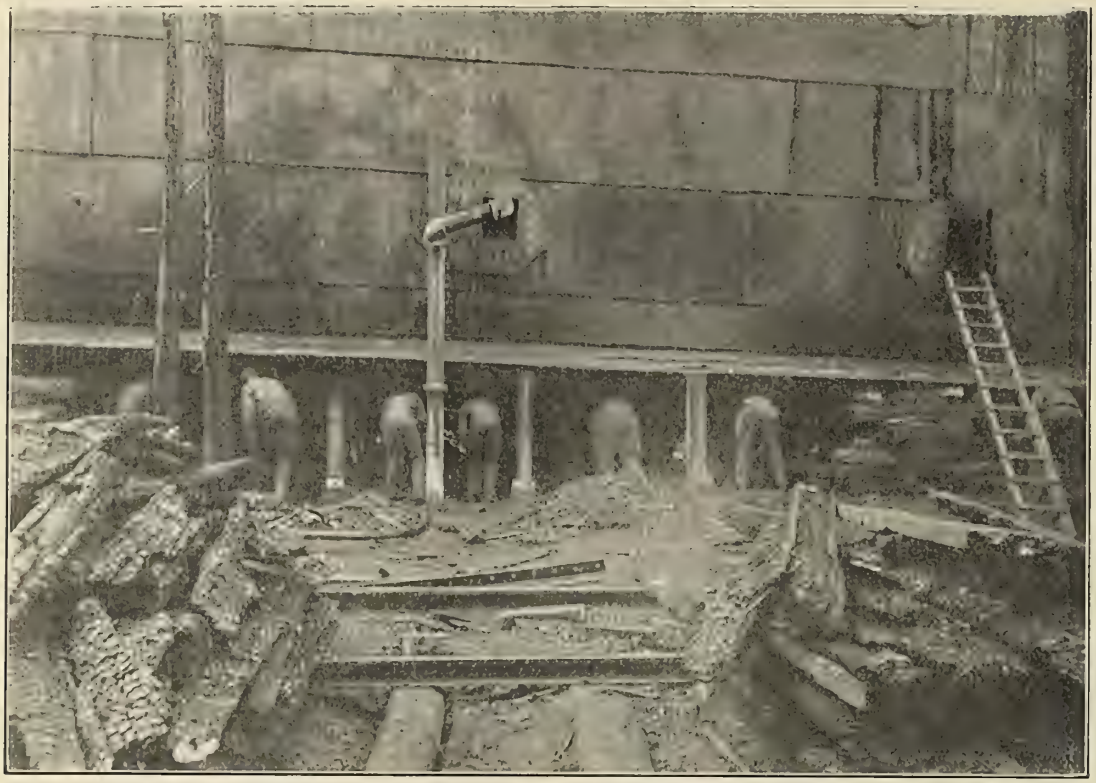
BOILER DATA.

Dia. inside		16'6"
Length		10'5"
Pressure		160 lbs.
Heating Surface	Tubes	2373.2
	Furnaces	168.5
	Combs. Chamber	226.3
Total, 1 boiler		2768 sq. ft.
Grate surface		88 sq. ft.
Ratio H.S. to G.S.		31.4
No. of plain tubes # 11 B.W.G.		342
" " stay " # 6 "		184
Total		526

Marine Engineering

FOUR-FURNACE SINGLE-END SCOTCH BOILER FOR THE CAPTAIN A. F. LUCAS, BUILT BY THE WILLIAM R. TRIGG COMPANY.

FOR DESCRIPTION SEE PAGE 604.



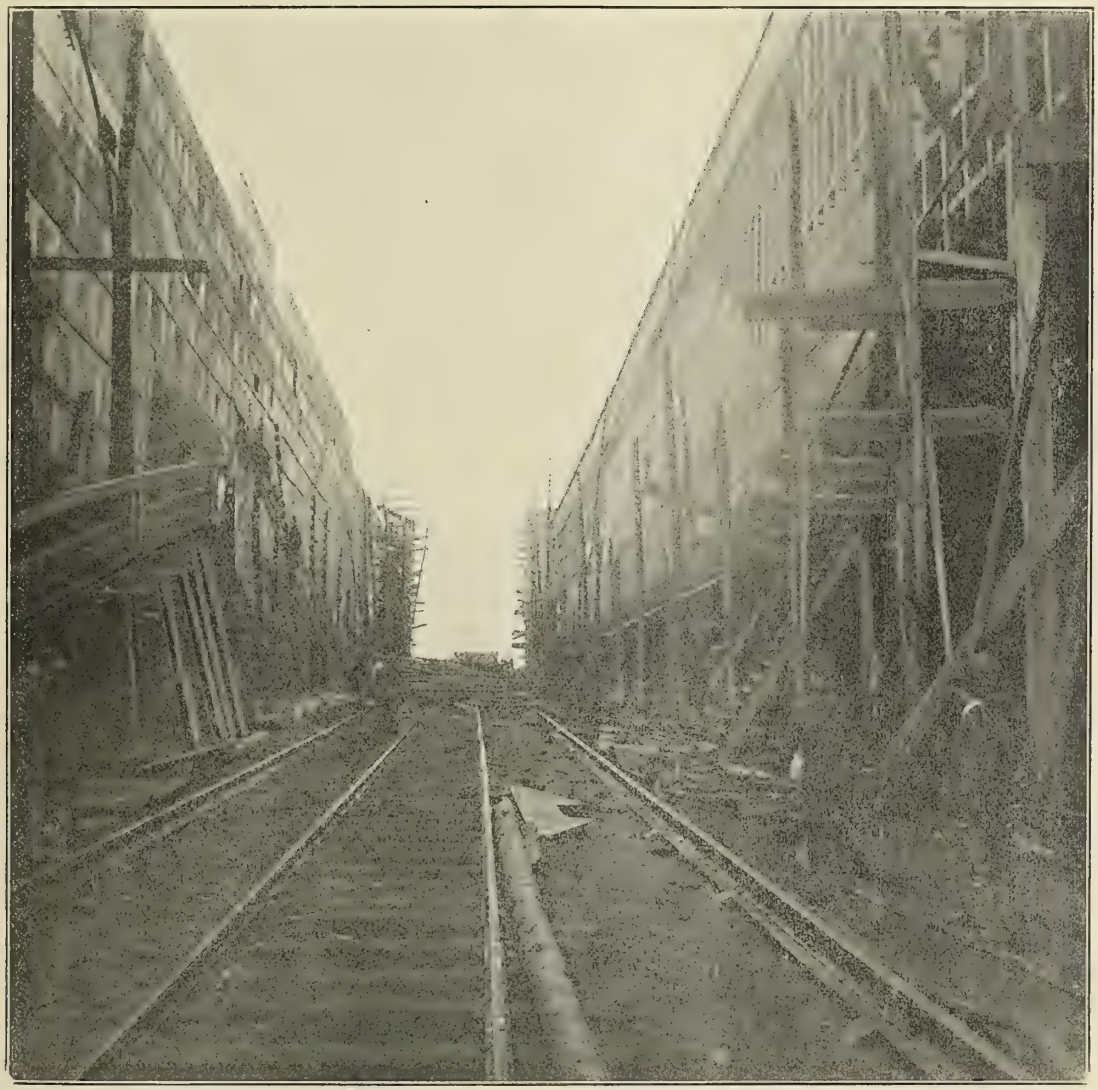
TAKING OUT THE BURNED SHORES AND BLOCKS.

The amount that the ship settled can be seen by the pipe at the middle of picture, which was formerly at the center of opening.

THE BURNED WAYS AND SHORING UNDER THE MISSOURI.

she having settled about two feet when the middle supports were burned out.

Much progress has been made in replacing the burned portions of the building ways, General Manager Mr. A. G. Wilson giving this his personal attention, and from present indications the work of righting and raising the *Missouri* will be accomplished before this article reaches the reader's hands.



BETWEEN THE SHIPS AFTER THE FIRE, THE MISSOURI AT THE LEFT, THE MAINE AT THE RIGHT.
The staging was burned from both ships at this point.

Trial of the Destroyer Stewart.—The torpedo-boat destroyer *Stewart* left the yard of the Gas Engine and Power Company and Charles L. Seabury and Company, Morris Heights, New York city, on October 20 and proceeded to Newport, where the trials were conducted two days later. The required speed was 26 knots, and the maximum speed attained over the measured course, with the corrections for tide, was 29.7 knots. Steam pressure at the boiler was 265 pounds, at the throttle 250 pounds, first receiver 80 pounds, second receiver 16 pounds; vacuum, 27 1-2 inches; average revolutions, 330. The trial was very successful and there were no mishaps of any kind.

GAS ENGINES AND THEIR TROUBLES.—VII.

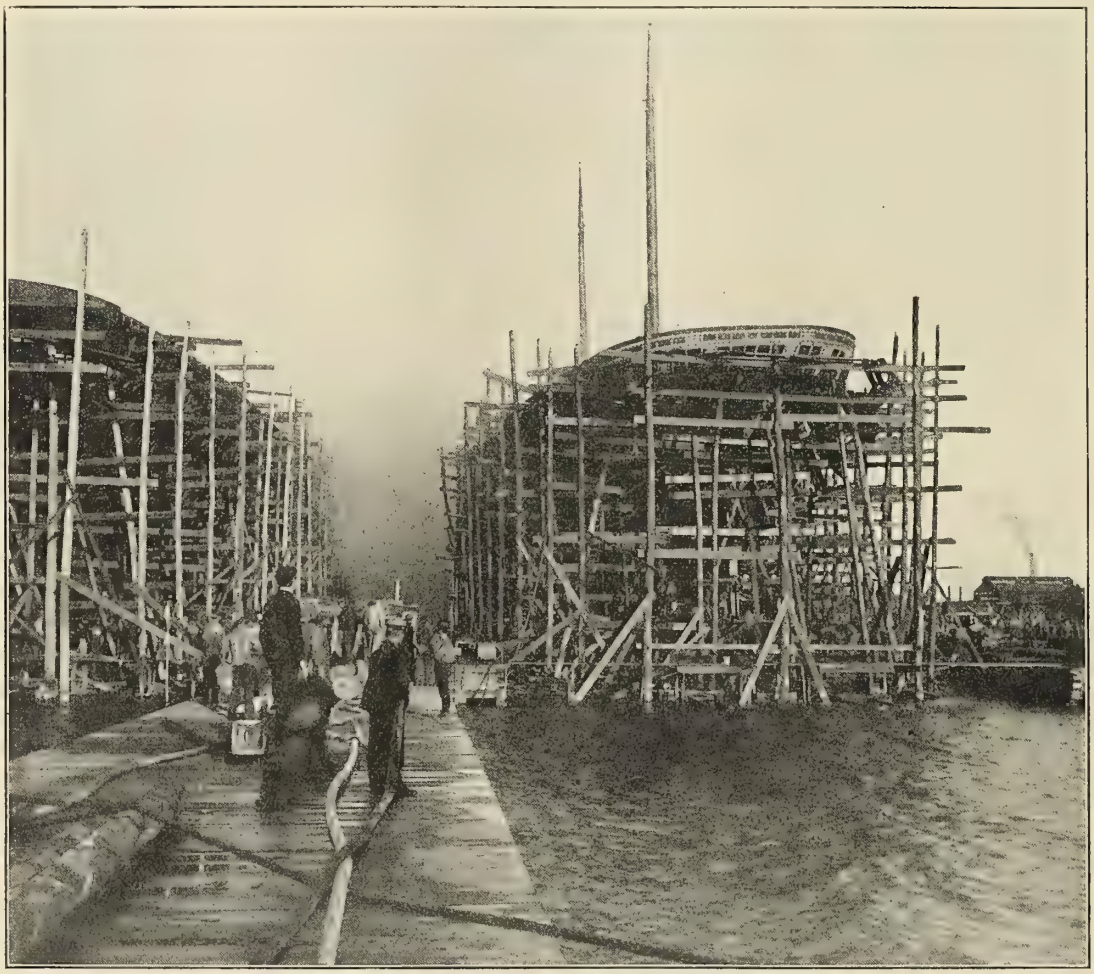
BY E. W. ROBERTS.

In order to illustrate, more pointedly than can be accomplished by a tabulation of possibilities, just how to set an engine in order that is acting badly, I will give a few actual examples of trouble-hunting, showing just what course is pursued when seeking the cause of the derangement. It must not be understood by the reader that when a certain set of symptoms have been traced to a certain source in the following accounts, a similar set of symptoms will in every case mean the same ailment. For instance, an engine may fall off in power from several different causes, any one of which will show the same symptom—*i. e.*, failure to develop the full power. Above all things, do not jump at conclusions, but go to work systematically and omit no test that indications do not prove to be absolutely unnecessary. It is by systematic working only that source of trouble can be found with any chance of promptitude.

As an example of what may occur from ignorance only, I was called upon one day to look at an engine

which was found hard to start and after being started would run some fifteen or twenty revolutions and then stop. In order to find out what was the matter I had the operator start it several times, for, as the engine was fresh from the factory, it was quite proper to assume that the operator was at fault. He seemed to think there was something the matter with his ignition, but I noticed, particularly when the engine seemed inclined to slow down, that he immediately gave the gasoline valve an extra turn, just as one would the throttle of a steam engine. I took the engine in hand and examined the electrical circuits, which were in good order, but on turning the engine over I found that some one had been "monkeying" with the igniter and that it was set to ignite half-way down the expansion stroke. I attempted to show the owner of the boat what was the matter, but he would not believe it was his fault, and I gave it up in disgust. As I was the only one in town who understood gas engines, he came to me a week later in sorrow and repentance, begging me to get his engine into working order, as he wanted to go on a trip. I made an appointment for the following morning at 8 o'clock, and going to the boathouse earlier than the appointed time, I advanced the lead of the igniter, and by the time the owner got there I was ready to start down the lake. While on that trip I gave the gentleman some strong words of advice, which he heeded, with the consequence that he had no more trouble with his engine the whole summer long.

Starting for the lake one day with a little four-horse-power two-cycle motor launch, it slowed up gradually and finally stopped altogether without any apparent cause. The gasoline valve was set properly, as I found upon examination, and had not been jarred out of position. Removing the wire from the insulated electrode and snapping it across one of the cylinder-head nuts, there was a good, bright spark, and upon turning the engine over to the ignition position it was found that the electrodes came together and separated at the proper time. I tested for this as follows: I kept scraping the wire on the insulated electrode, and turned the flywheel over slowly until such point was reached that a spark was produced when the piston was near the end of the stroke and just as the igniter mechanism showed that the electrodes should be brought together. Then just after the igniter snapped I could get no spark by scraping the end of the insulated electrode, showing that the electric circuit had been properly broken. The spark was bright and "fat," and the conclusion was that nothing was the matter with the igniter; but when testing the igniter I



FIGHTING THE FIRE OF THE MISSOURI FROM THE WATER.

found that the engine turned unaccountably hard and the cylinder was very hot. The heat extended back along the feed pipe from the circulating pump, and upon unscrewing the suction check the source of the trouble was revealed—the valve could not return to its seat on account of being clogged with dirt. After cleaning the valve and allowing the engine a few minutes to cool, it started up readily, and I went on my way rejoicing.

A case of jump-spark trouble on an engine that was designed for high speed for racing purposes was very difficult to trace. The engine—a two-cycle—ran very nicely at speeds under 500 r.p.m., but upon exceeding that speed misfires were frequent, while as soon as the engine was throttled down it ran steadily. It looked very much like a case of weak battery, but upon examination, even after running for some time, the battery showed no sign of falling off in pressure. A close examination of the wiring developed no loose connection, and the removal of the spark plugs showed them to be bright and clean, as were the contacts on the circuit breaker. Finally some one suggested that the springs on the circuit breaker were not stiff enough to let them bring the contacts together at the higher speed. Assisting the springs with the fingers while the engine was running showed this to be the probable cause of the trouble, as it helped matters greatly. In fact, stiffening up the springs solved the problem, and there was no further trouble from that source.

A four-cycle engine which had been running for some time had gradually fallen off in power until it could scarcely carry any load at all. A thorough examination of the igniter showed it to be in good working order, the mixer was set the same as it had always been, and there was no obstruction in the gasoline pipe, as was shown by opening the needle valve and allowing the fuel to run through. Disengaging the exhaust valve from the rocker arm which operated it, and turning the engine over slowly, the power which it took to move it as the piston neared the end of the stroke proved that there was no leakage past the piston. The suction was strong and there was nothing the matter with the inlet valve, and finally the trouble was laid at the door of the exhaust valve. It was found that the valve spring was weak, and upon tightening it up and grinding in the exhaust valve, which seemed to be leaking slightly, the engine ran as good as it ever had done.

In another case similar to the above the engine was falling off in power, and the customary routine was gone through with, examining the igniter, the mixer, and the valves, but without finding the source of the trouble, as everything seemed to be in fine working order. The engine was of the four-cycle type and employed an auxiliary exhaust port similar to the exhaust port in a two-cycle engine, the usual mushroom valve being just sufficient in size to allow the engine to clear itself on the exhaust stroke. It was finally decided to remove the cylinder head, and upon turning the piston toward the crank to the end of the stroke, examination of the auxiliary port was attempted, but, to the astonishment of all, no such port was in evidence. The man who was making the examination was from the factory where the engine was made, and as the engine had made a good showing on the testing block he was absolutely certain that the port was in place when the engine left the shop. Finally the reflection from the torch with which he was examining the cylinder showed him the outline of where the port had once been, and further investigation developed the fact that it was choked up tight with carbon, which had to be cut out with a cold chisel. On questioning the operator, it was found that gas-engine oil at 15 cents a gallon "wasn't good enough" for his engine, so he used a heavy steam-engine cylinder oil costing 60 cents a gallon, as he was quite certain that the price had a great deal to do with its adaptability to the engine. It was the heavy oil that had caused the hard deposit of soot, and the case was an excellent example of how not to do it.

The above instance of ignorance was, however, not quite so bad as that of the man in Memphis who, finding that he was short of oil, but had plenty of molasses, used the latter as a substitute. It is scarcely necessary to add that the piston was stuck in the cylinder. So poor was the quality of this lubricant, in fact, that the piston pin was in a very short time worn half in two. The greatest mystery about the affair is how the engine managed to run at all. It probably would not have done so had it not been for the fact that the molasses was used on the bearings for some time before it was introduced into the cylinder. It is needless to say that the repair man on this job gave the operator a short talk on lubricants.

A source of trouble which is often difficult to trace, and which is at the same time very annoying, is illustrated by the following example: A gentleman in St. Louis was running an engine which worked very well for a time, but finally developed a trait of starting off very nicely, but stopping after it had made some half dozen revolutions or so. No matter how often he tried, the engine would always stop after the first few strokes, but never failed to start easily. He wrote to me for a diagnosis, and I told him to start at the battery, examine it to see if it was weak, brighten up every connection and screw it up tight, see that his induction coil was perfectly dry, and examine his igniter for a short circuit. But, above all things, I told him to look for a vibrating connection. This is one which is usually developed by the wire breaking inside of the insulation, and although the ends are in contact while the engine is standing still, the vibration when the engine is running causes the ends to separate and come together, with the result that there are frequent misfires owing to the broken ends being parted at the same time the electrodes are separated inside the engine. Shortly afterward I received a letter from the man, saying that he had found a vibrating connection caused by the wire being held against the binding post of the coil by the frayed end of the covering. So soon as the engine started it would shake the wire away from the binding post, thus breaking the circuit.

A boat had just come in from a race after carrying off the first honors, and the engine had been allowed to cool down while the races for the higher-power boats were in progress. Although entered in another race, the boat did not start in it, and, being acquainted with the owner, I went to see what was the matter. Imagine my astonishment when I found he could not start his engine. He was rather crestfallen, as he had some ten miles to go home, and asked me to help him out. He said he had plenty of gasoline and a good spark, etc., but that the mixer valve seemed to be in bad shape, as the engine—

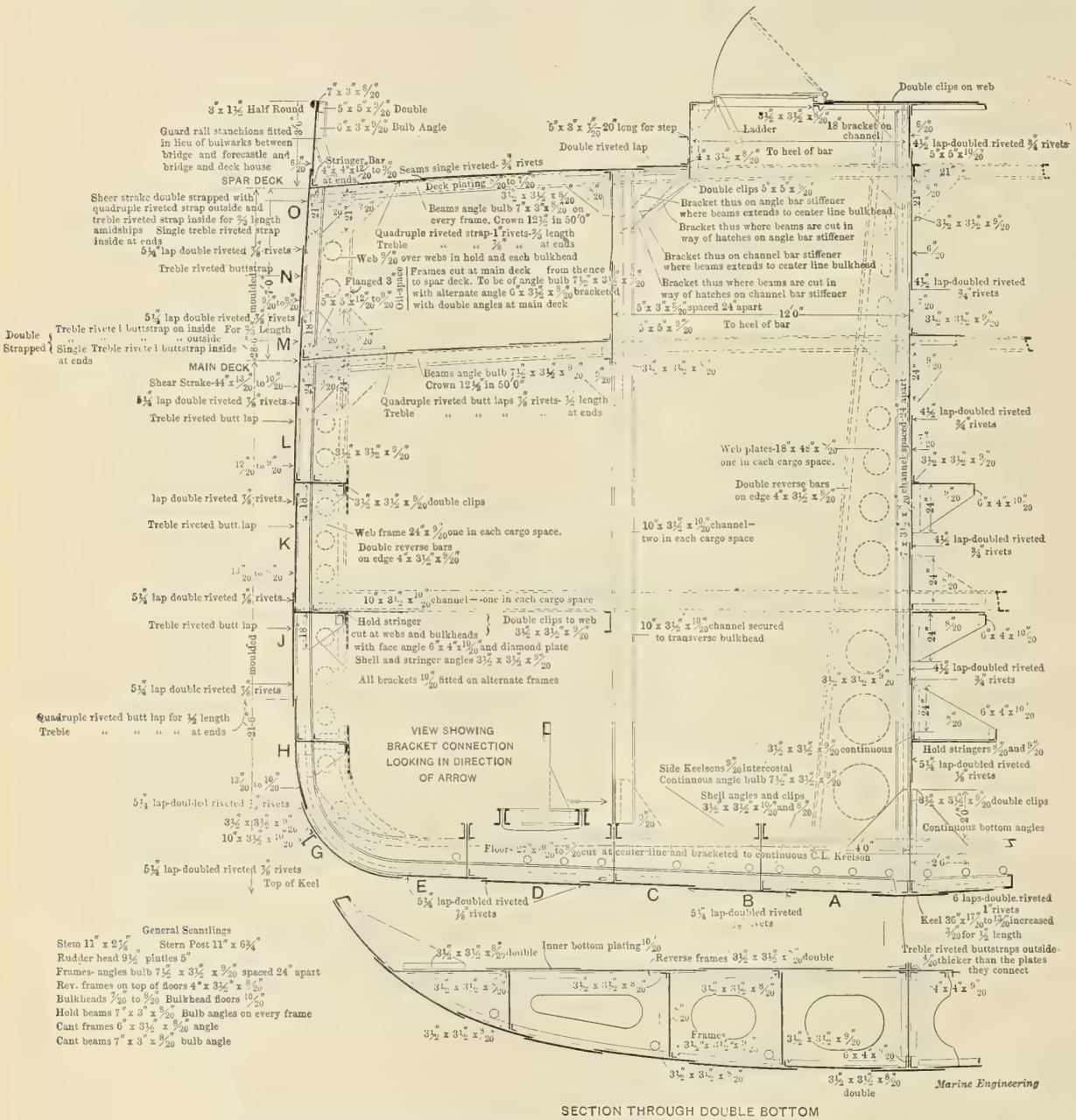
a two-cycle—was apparently flooded. Three of us took turns cranking the engine, in order to pump the gasoline out, but with no success. After quite a little cranking I noticed that there was very little odor of gasoline, such as there should have been had we been pumping the raw vapor into the exhaust. Thinking that possibly the gasoline valve might be clogged, I gave it about four times its usual opening, and, turning the engine over a couple of times, secured an explosion; and immediately closing the valve to its running position, I kept the engine going. It was a case of dirt in the gasoline pipe, and this was immediately removed by flushing the valve and connection when giving the valve such a wide opening.

(To be continued.)

NEW LARGE OIL-TANK STEAMER CAPTAIN A. F. LUCAS.

To meet the demand for transporting fuel oil, which has grown so enormously since the discovery of oil in Texas, a large fleet of oil carriers is now under construction both at home and abroad, including steamers and barges. Besides these specially-built vessels, several of our shipyards have been very busy remodeling freight steamers for carrying oil. It is never possible, however, to remodel a vessel built for one purpose, so that she will best be suited for another service. Oil-tank work is comparatively new, and in large vessels many new problems have been met with.

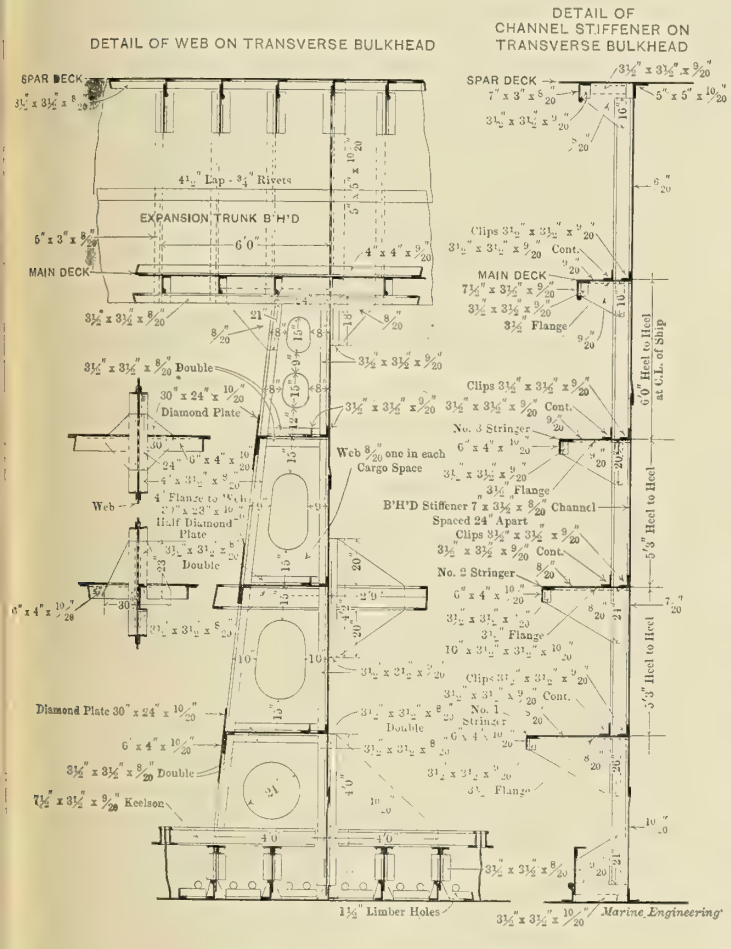
The largest of the American fleet yet laid down is that building at the yard of the William R. Trigg Com-



SECTION THROUGH DOUBLE BOTTOM

MIDSHIP SECTION OF STANDARD OIL TANK STEAMER CAPTAIN A. F. LUCAS.

pany, Richmond, Va., for the Standard Oil Company. The vessel is 360 feet over all and is designed to carry 1,500,000 gallons of oil in bulk and 700 tons of fuel oil on a draft of 22 feet 5 inches. The ship is of the spar-deck type, with complete spar and main decks, forecastle, bridge house, and a house aft around the machinery. She is built to the highest class of Lloyds and the American Bureau of Shipping, and the specifications call for a vessel built from the best material and equipped, when completed, ready for service in every respect.



DETAILS OF BULKHEAD STIFFENERS.

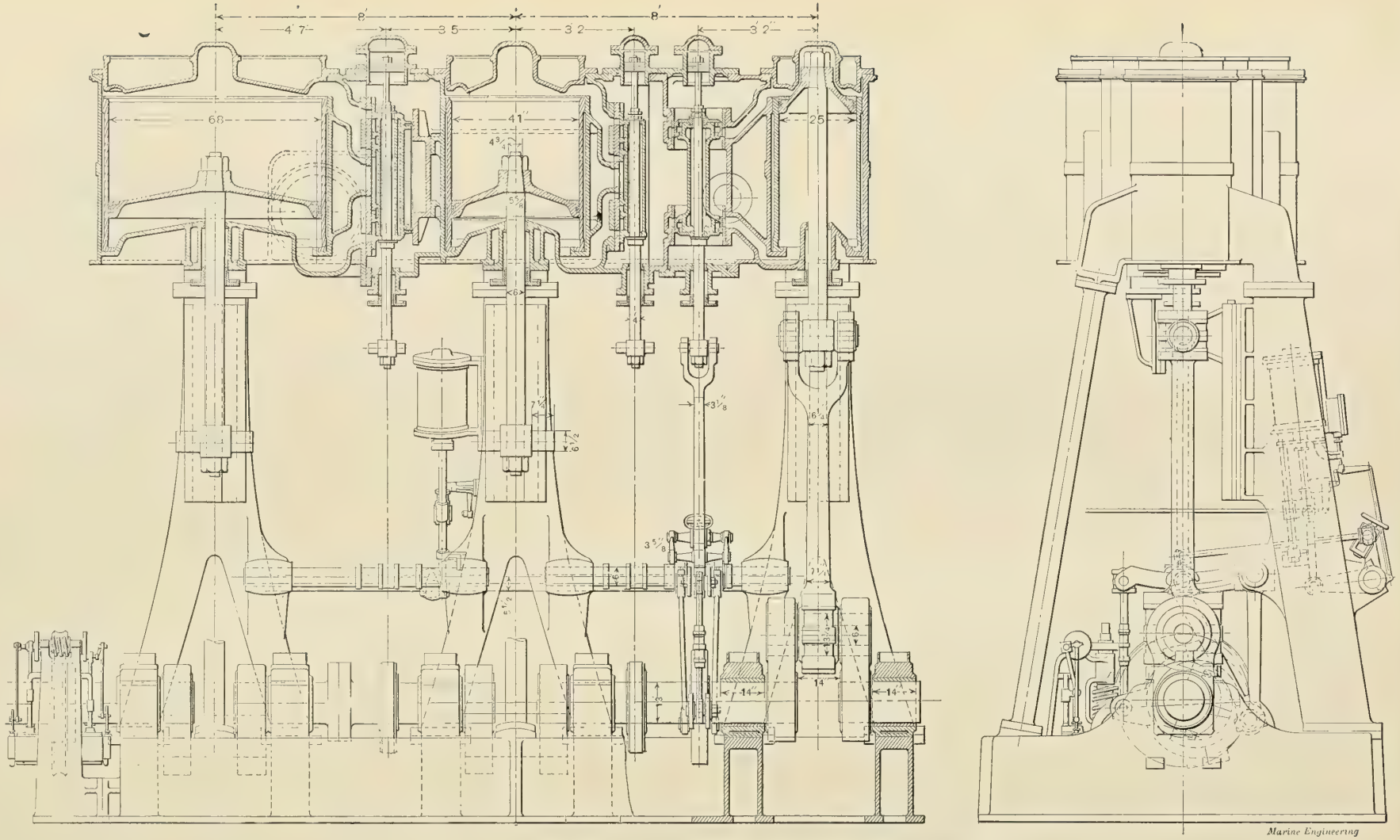
Any plates which are over 10-20 inch in thickness must have all the holes reamed. The stem is of hammered scrap iron 11 by 27-8 inches, tapered to 11 by 21-2 inches at the top. The stern frame is of cast steel 11 by 63-4 inches, in one piece with the rudder post, and the rudder is also cast steel with wrought-iron stock 9 1-2 inches diameter. The pintles are of forged steel 5 inches diameter, and the weight is carried by a bearing on the deck.

The frames, which are of 7 1-2 by 3 1-4 by 11-20 to 9-20-inch bulb angles, are spaced 24 inches. Forward of the collision bulkhead they are gradually brought together until they reach a spacing of 12 inches at the stem; between the main and spar decks are bulb angle and plain angle alternatingly, and the same in the forecastle. Alternate frames aft of the oil compartment extend to the spar deck. The framing on the bulkhead is 5 by 5 by 10-20 inch, and the edges are beveled for calking. The floors are 27 inches deep by 10-20 inch; at the ends the depth is increased and the thickness reduced to 8-20 inch, where they extend across in one piece. The flat plate keel is 36 inches wide and for half length amidships is 1 inch thick, gradually reducing to 13-20 inch at the ends. The center keelson, 60 inches by 12-20 inch, is continuous through the oil compartments, bunkers, boiler and engine rooms. There are three sister keelsons on each side, intercostal, with double angle bulbs on upper edge and well bracketed at the bulkheads. At the ends some of these keelsons are combined and connected by breast hooks. In each compartment and in the engine and boiler room spaces is a web frame 24 inches deep.

The shell plating is laid in outside and inside strakes, of dimensions given on the drawing, where will also be found the figures for the deck plating. In the forward hold and aft of engine room there is a lower steel deck. The main and spar deck beams are of bulb angle placed on every frame. The cargo space is divided into sixteen oil-tight compartments by nine transverse and one longitudinal bulkhead, each compartment made absolutely tight. The longitudinal bulkhead plates run horizontally, the transverse ones running vertically. The longitudinal bulkhead is stiffened by web frames, one placed in each tank on the port side. The transverse bulkheads are each stiffened by two web frames, one on each side of the bulkhead in alternate tanks. These frames are 4 feet wide at the bottom, and the transverse ones are 2 feet at the top, and on the longitudinal bulkheads they are 18 inches at the top, all of 8-20-inch plate. There are three horizontal stiffeners connected to the bulkheads and webs, as shown in the plan. All the webs and horizontal stiffeners are connected by diamond plates. A cofferdam of two bulkheads, one frame space apart, is arranged between the coal bunker and the after oil compartment. The forward bulkhead of this cofferdam is fitted between double angles. From the after cofferdam bulkhead to two frame spaces forward of after peak bulkhead extends a double bottom from the center line to the ship's sides.

Bilge keels extend for about 200 feet amidships and are made of bulb angle 10 by 3 1-2 by 10-20 inch with an angle iron 3 1-2 by 3 1-2 by 9-20 inch. The forecastle is 7 feet 6 inches high, decked over with Oregon pine. The bridge and after deck houses are the same height of 7-20-inch side plating. All doors are made of steel with water-tight fittings. The forward peak has a water-tight flat on a level with the lower deck, and in the upper forepeak are chain lockers.

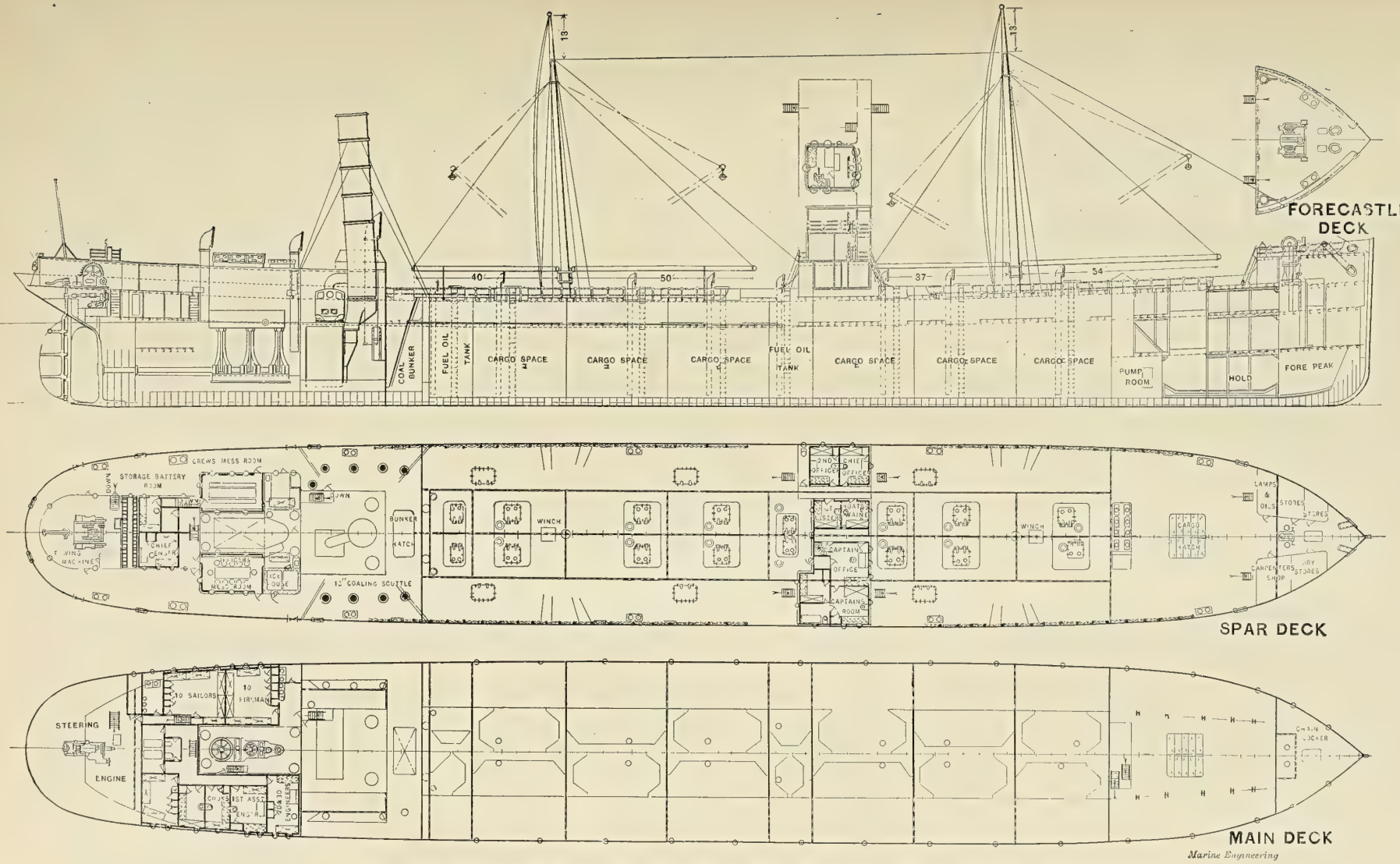
The riveting and calking has been done with extra care and the double bars on the cofferdam and end bulkheads are calked on both sides. Where possible, all calking and reaming was done with pneumatic tools. The size and pitch of the riveting is according to the rules, except in the cargo spaces, where the pitch will be 3 1-4 diameters. The countersinks are of uniform size, well filled, and the heads well laid up. When completed, all the oil compartments, the cofferdam, and the fuel-oil tanks are to be tested separately before the vessel is launched, and each compartment must be made absolutely tight with a head of water 10 feet above the top of the



ENGINES OF THE CAPTAIN A. F. LUCAS, BUILDING AT RICHMOND, VA., BY WILLIAM R. TRIGG COMPANY.

expansion trunk. The fresh-water tanks and double bottom are also to be tested. All work is to be made tight, iron to iron.

The general arrangement of the ship is well shown in the accompanying longitudinal and deck plans. It will be seen that the machinery is placed aft, leaving a clear space of 230 feet for cargo and oil fuel. The oil fuel is carried in two 'thwartship compartments, one about amidships and the other aft. The forward hold, which is 46 feet long, is fitted for carrying general cargo. An expansion trunk extends from the main to the spar decks, fore and aft, over the oil compartments at a distance of



SECTIONAL LONGITUDINAL ELEVATION AND DECK PLANS OF OIL TANK STEAMER CAPTAIN A. F. LUCAS.

12 feet from the center line. Over each compartment on the spar deck are located the cargo hatches, and in the top of each is fitted a small water-tight hinged door about 4 feet square. Smaller hatches are located above the fuel-oil tanks.

Forward of the oil compartments in the hold is a steel trunk extending down to the pump room, in which are located two oil pumps and one ballast and bilge pump with necessary suction and discharge valves. On each

side of the spar deck there are three side hatches, 4 by 6 feet, fitted with water-tight steel covers.

The ship is to have two steel masts 28 inches diameter at the heel, and short Oregon tops. The mast steps are of cast steel, placed on the spar deck directly above the transverse bulkheads. The four booms on each mast are of sufficient length to reach all the hatches, and a winch is placed at each mast. A large windlass is located on the forecastle for working the stockless anchors, which are to be stowed in hawse pipes. The two side lights are placed in steel light-house towers at the break of the forecastle.

Turning now to the crew's quarters, we find in the midship house commodious accommodations for the captain, second officer, chief engineer, quartermasters, and boatswains. Above is the pilot house, on top of this is the bridge.

On the spar deck, abreast of the engine hatch, are the officers' and crew's mess rooms, the galley, and quarters for the chief engineer and steward. The after end of the house is taken up by the towing machine. On the deck below are the quarters of the assistant engineers, oilers, sailors and firement, lavatories, and storerooms. The steering engine, which is of the Hyde type, is just forward of the rudder.

Bunkers for 500 tons of coal extend across the forward ends and sides of the fire room. Coal is loaded through nine iron coaling scuttles, and one large hatch on the spar deck.

Now turning to the machinery, the vessel is to be driven by a triple-expansion engine with diameters of cylinders 25, 41, and 68 inches, all having a common stroke of 42 inches running at 100 revolutions. The engine is designed to indicate about 2,000 horse power. The cylinders are of best cast iron, fitted with relief valves, drain cocks, indicator cocks, etc., lagged with magnesia and covered with Russia sheet iron with heavy brass strips. Each is fitted with a close-grained cast-iron lining. The high-pressure cylinder is fitted with a piston valve with cast-iron liner; the intermediate and low pressure are arranged for double-ported slide valve working on a false face. The valves are operated by the Lang radial valve gear, and reversing is accomplished by a steam engine mounted on the back framing of the intermediate pressure cylinder. The pistons are of cast steel, dished type, with packing rings and follower plate.

The piston rods and connecting rods with their bolts are of forged steel, which is the material also used for the slipper crosshead. The crank shaft is of forged steel, built up in two pieces with couplings forged on, and of 13 inches diameter. The crank pins are 13 1-4 inches diameter with a 6-inch hole. The webs are of cast steel. The thrust and propeller shafts are also of steel and the latter is covered with brass liners. Between the liners is a copper tinned liner with edges calked to prevent water getting at the shaft. The bed plate and back frames are of cast iron, the frames being of box shape, bolted to the bed plate. The front frames are of forged steel turned and finished.

The condenser is a separate iron casting of the cylindrical type, fitted with 3-4-inch brass tubes, giving a cooling surface of 4,500 square feet. The air pump is of the vertical duplex Blake type with cylinders 10, 22 by 15 inches. The circulating centrifugal pump is driven by a 12 by 10-inch engine. The main feed pump is also of the Blake vertical duplex style, 10 by 7 by 12 inches. A 20-ton evaporator is connected with the feed heater and condenser and is covered with magnesia. The necessary feed, fire, bilge, sanitary, and donkey pumps are provided.

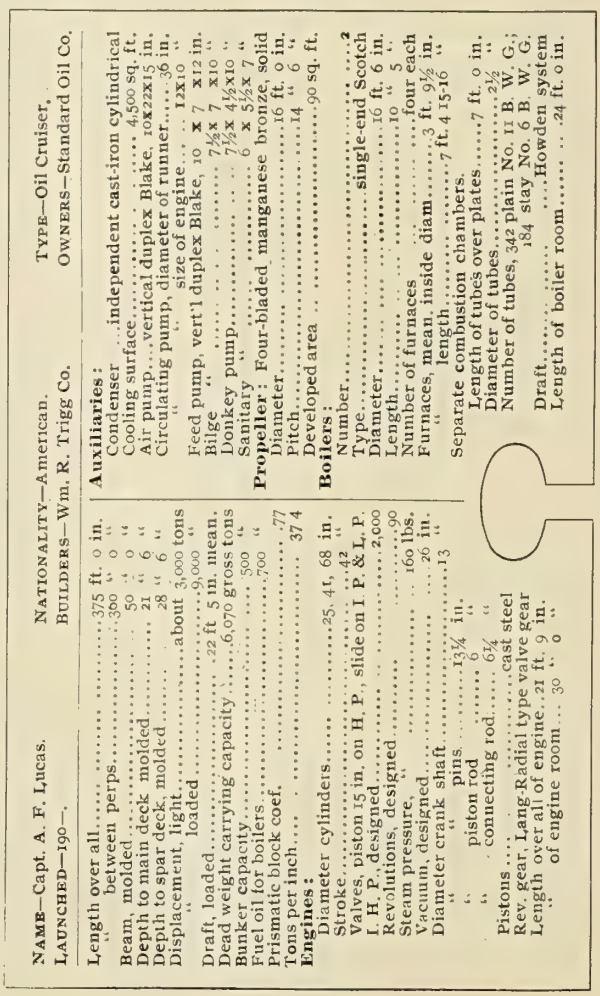
The two boilers, which are arranged in a 'thwartship fire room, are of the Scotch single-end type, 10 feet 5 inches long by 16 feet 6 inches in diameter, and built for a working pressure of 160 pounds. The construction and detail of these boilers is given on the inset opposite page 599. The heating surface of one boiler is 2,768 square feet, made up as follows: 2373.2 in the tubes, 168.5 in the furnaces, 226.3 in the combustion chambers. There are four suspension furnaces of 48 inches outside diameter, each having separate combustion chamber. The tubes are of best charcoal iron, 2 1-2 inches diameter, and the plain tubes are of No. 11 B.W.G., the stay tubes of No. 6 B.W.G.

The boilers are provided with the Howden system of forced draft for burning either oil or coal.

The smokestack extends 80 feet above the grates. There is a water-tube donkey boiler, with 40 feet of grate and 1,200 square feet of heating surface, placed in the boiler hatch on the main deck.

Name—Capt. A. F. Lucas. **Nationality**—American. **Type**—Oil Cruiser,
Launched—190—. **Builders**—Wm. R. Trigg Co. **Owners**—Standard Oil Co.

Length over all	375 ft. 0 in.	**Auxiliaries:**	
" between perps	360 " 0 "	Condenser	independent cast-iron cylindrical
Beam, molded	50 " 0 "	Cooling surface	4,500 sq. ft.
Depth to main deck, molded	21 " 6 "	Air pump	vertical duplex Blake, 10x22x15 in.
Depth to spar deck, molded	28 " 6 "	Circulating pump, diameter of runner	36 in.
Displacement, light	about 3,000 tons	" size of engine	12x10 "
" loaded	9,000 "	Feed pump, vert'l duplex Blake,	10 x 7 x 12 in.
Draft, loaded	22 ft. 5 in. mean.	Bilge "	7½ x 7 x 10 "
Dead weight carrying capacity	6,070 gross tons	Donkey pump	7½ x 4½ x 10 "
Bunker capacity	500 "	Sanitary "	6 x 5½ x 7 "
Fuel oil for boilers	700 "	**Propeller:** Four-bladed manganese bronze, solid	
Prismatic block coef.	.77	Diameter	16 ft. 0 in.
Tons per inch	37.4	Pitch	14 " 6 "
Engines:		Developed area	90 sq. ft.
Diameter cylinders	25, 41, 68 in.	**Boilers:**	
Stroke	42 "	Number	2
Valves, piston 15 in. on H. P., slide on I. P. & L. P.		Type	single-end Scotch
I. H. P., designed	2,000	Diameter	16 ft. 6 in.
Revolutions, designed	90	Length	10 " 5 "
Steam pressure, "	160 lbs.	Number of furnaces	four each
Vacuum, designed	26 in.	Furnaces, mean, inside diam	3 ft. 9½ in.
Diameter crank shaft	13 "	" length	7 ft. 4 15-16 "
" " pins	13¼ in.	Separate combustion chambers.	
" piston rod	6¼ "	Length of tubes over plates	7 ft. 0 in.
" connecting rod	6¼ "	Diameter of tubes	2½ "
Pistons	cast steel	Number of tubes, 342 plain No. 11 B. W. G.;	
Rev. gear, Lang-Radial type valve gear		184 stay No. 6 B. W. G.	
Length over all of engine	21 ft. 9 in.	Draft	Howden system
" of engine room	30 " 0 "	Length of boiler room	24 ft. 0 in.



TENTH GENERAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The tenth annual meeting of the Society of Naval Architects and Marine Engineers was held on Thursday and Friday, November 20 and 21, in the assembly rooms of the American Society of Mechanical Engineers, 12 West Thirty-first street, New York city. The papers presented elicited much general discussion from members present.

The first regular session was called to order on Thursday morning at 10.30 o'clock with President Griscom in the chair. The first business was the report from the secretary-treasurer, which was received and adopted. The council presented the following lists of applicants to admission in the various grades of the Society. The names were read by the secretary and upon motion the applicants were unanimously elected members:

Members, 30.—Thomas Edward Artis, chief draftsman, Bath Iron Works, Bath, Me.; George Hale Barrus, mechanical engineer, 12 Pemberton square, Boston, Mass.; Francis Wyckoff Belknap, chief draftsman, Gardner and Cox, 1 Broadway, New York; Holden Allen Evans, assistant naval constructor, U. S. N., navy yard, Norfolk, Va.; Deltof Albert Hector, draftsman, Fore River S. and E. Co., Quincy, Mass.; Frederick Maxfield Hoyt, president, Greenport Basin and Construction Co., Greenport, N. Y.; William Hovgaard, professor of naval designs, Massachusetts Institute of Technology, Boston, Mass.; James McKinley, marine draftsman, Union Iron Works, San Francisco, Cal.; Albert J. Mickley, mechanical draftsman, Department of Docks and Ferries, New York city, N. Y.; Edmund Mills, in charge of marine department, The Babcock and Wilcox Co., Bayonne, N. J.; Leonard J. Nilson, proprietor, The Nilson Yacht Building Company, Ferry Bar, Baltimore, Md.; Charles O'Neil, rear admiral, U. S. N., chief of the Bureau of Ordnance, U. S. Navy, Navy Department, Washington, D. C.; Thomas Dorsey Pitts, chief draftsman, Tams, Lemoine and Crane, 52 Pine street, New York; Charles Bradley Rowland, assistant secretary and engineer, The Continental Iron Works, Brooklyn, N. Y.; Charles Schofield, superintendent, Eastern Shipbuilding Company, New London, Conn.; John Addison Baxter Smith, captain U. S. N., head of Department of Steam Engineering, navy yard, Brooklyn, N. Y.; John Amos Stevens, chief engineer, Merrimack Manufacturing Company, Lowell, Mass.; Frank Noyes Tandy, naval designer, 31 State street, Boston, Mass.; Philip Marshall Young, chief draftsman, Engine Department, New York Shipbuilding Company, Camden, N. J.; Rudolph Zirpel, superintendent of construction, U. S. Lighthouse Service, 525 Third street, N. E., Washington, D. C.; George H. Eimert, Axel B. Wallen, Arthur L. Busch, James F. Waddington, Edward Smith, Lieutenant Albert Moritz, U. S. N.; Rear Admiral P. C. Asserson, U. S. N.; Archibald Johnston, Antonius Jervis d'Athouguia, Perley F. Walker.

Associates, 19.—Adolph E. Boric, vice-president, Bethlehem Steel Company, South Bethlehem, Pa.; Philip B. Brill, calculating draftsman, Hull Department, William Cramp and Sons' S. and E. B. Co., Philadelphia, Pa.; David W. Dickie, draftsman in charge, office of supervising constructor, Moran Brothers Company, Seattle, Wash.; Edward Persall Field, 53 West Forty-sixth street, New York city; General Eugene Griffin, vice-president, General Electric Company, 44 Broad street, New York; Geo. McQuilken, Jr., electrical expert, Bureau of C. and R., U. S. N., Bath, Me.; Edward M. McIlwain, president, Bethlehem Steel Company, South Bethlehem, Pa.; Edwin Alan Perkins, naval architect and engineer, Maritime Building, New York, N. Y.; Matthew Bowen Pollock, carpenter U. S. Navy, U. S. S. *Indiana;* Rowland A. Robbins, president Manhattan Supply Company, New York, N. Y.; Henry B. Shields, draftsman, office of superintending constructor, The William Cramp and Sons' S. and E. B. Co., Philadelphia, Pa.; Hayden Hobart Smith, manager, Marine Department, Thresher Electric Company, Dayton, Ohio; Henry S. Snyder, secretary-treasurer, Bethlehem Steel Company, South Bethlehem, Pa.; Henry C. Watts, Clark H. Woodward, William D. Dimock, R. J. Donovan, Henry Rice, John J. Armory.

Promotion from Associate to Member, 7.—D. H. Cox, assistant naval constructor, U. S. N., Bureau C. and R., Navy Department, Washington, D. C.; Charles James Dougherty, electrical engineer, William Cramp and Sons' S. and E. B. Co., Philadelphia, Pa.; Wilbur F. Powers, leading hull draftsman, Moran Brothers Company, Seattle, Wash.; Richard H. M. Robinson, assistant naval constructor, navy yard, New York; Edson B. Schock, naval architect, 17 State street, New York; James William Lowry Waters, surveyor, American Bureau of Shipping, 66 Beaver street, New York; Walter A. Post.

Promotion from Junior to Member, 4.—Webb R. Ballord, Henry N. Whittelsey, Morris M. Whitaker, Dean Clark.

Juniors, 52.—Harry B. Appleby, draftsman, Department of Yards and Docks, navy yard, Brooklyn, N. Y.; Moro Miller Bordon, engine draftsman, New York Shipbuilding Company, Camden, N. J.; Ross W. Bragg, draftsman, New York Shipbuilding Company, Camden, N. J.; Frank Edwin Craig, draftsman, Neafie and Levy S. and E. B. Co., Philadelphia, Pa.; Frank Harper Crane, superintendent, Theo. Crane's Sons Dry-Docks and Ship Yard, Erie Basin, Brooklyn, N. Y.; Owen Brooks Evans, draftsman, New York Shipbuilding Company, Camden, N. J.; William M. Finkenaur, draftsman, The William Cramp and Sons' S. and E. B. Co., Philadelphia, Pa.; Harry Lamar Grant, with New York Shipbuilding Company, Camden, N. J.; Henry J. Hack, draftsman, New York Shipbuilding Company, Camden, N. J.; Jay D. Hammond, draftsman, Townsend-Downey Shipbuilding Company, Shooters Island, N. Y.; Lyman Foster Hewins, ship draftsman, C. and R. Department, navy yard, Washington, D. C.; Joseph Hunt Holt, draftsman, Marine Department, Midvale Steel Company, Philadelphia; James W. Hussey, draftsman, Scientific Department, New York Shipbuilding Company, Camden, N. J.; Alfred C. Jennings, hull draftsman, Eastern Shipbuilding Company, New London,

Conn.; Martin C. Kindlund, chief hull draftsman, Burlee Dry-Dock Company, Port Richmond, S. I., N. Y.; Luther W. Krout, assistant draftsman, office of superintending constructor, Harlan and Hollingsworth Company, Wilmington, Del.; Charles L. Loos, Jr., hull draftsman, American Shipbuilding Company, Cleveland, Ohio; Alfred E. Luders, draftsman, Tams, Lemoine and Crane, 52 Pine street, New York; William MacHattie, foreman builder, Marine Engine and Machine Company, Harrison, N. J.; Clarence Lee Morrison, assistant calculator, William R. Trigg Company, Richmond, Va.; George Moses Purver, civil engineer, American Bridge Company, 7 West Twenty-second street, New York; Winthrop Melton Rice, draftsman, John N. Robins Company, Erie Basin, Brooklyn, N. Y.; John Alexander Ross, Jr., ship assistant draftsman, office of superintending constructor, Moran Brothers Company, Seattle, Wash.; Paul Alexander Suwald, draftsman, Hull Department, New York Shipbuilding Company, Camden, N. J.; Perry K. Thurston, draftsman, Neafie and Levy S. and E. B. Co., Philadelphia, Pa.; Charles C. Turner, hull draftsman, George Lawley and Sons Corporation, South Boston, Mass.; William Uzelmeier, marine draftsman, New York Shipbuilding Company, Camden, N. J.; Wassily W. Wassilieff, draftsman, L. Powers and Company, Philadelphia, Pa.; John M. Watts, mold loft drawing office, New York Shipbuilding Company, Camden, N. J.; Frank B. Whitaker, draftsman, naval constructor's office, Newport News S. B. and D. D. Co., Newport News, Va.; William W. White, draftsman, electrical department, The Wm. Cramp and Sons' S. and E. B. Co., Philadelphia, Pa.; Alex E. Zetterman, draftsman, George Lawley and Sons Corporation, South Boston, Mass.; Clyde Yeomans, assistant draftsman, C. and R. department, navy yard, New York; Lee R. Stewart, New York Shipbuilding Company, Camden, N. J.; John F. Sullivan, draftsman, navy yard, New York. N. Y.; Les Weir Brownrigg, draftsman, 80 West One Hundred and Thirty-second street, New York; Rowland Dimelow, boat builder, navy yard, Brooklyn, N. Y.; Edward B. Osborn, Croton-on-Hudson, N. Y.; William C. Stauke, draftsman, Western Electric Company, New York, N. Y.; Thomas E. Webb, Jr., draftsman, navy yard, New York; Howard C. Towle, Axel B. Tappan, Joseph S. Potter, Harold W. Patterson, Joseph G. Bradley, Edward Larhan, Joseph G. Purdy, Ernest Fils, Preston S. Stone, Clarence H. Harden, Lee H. Cummings, Henry B. Spear.

The principal feature of the business meeting was the adoption of the council's recommendation contained in its circular of October 24, which had been sent out to each member, whereby the annual dues of members and associates should be $10 per annum, entrance fees the same, and the dues of the junior members should be $5 per annum with initiation fee of $5. The vote of the Society received by mail was, in favor of the recommendation, 548; against the recommendation, 99; total votes cast, 657; total membership qualified to vote, 719. Upon vote, article iii. of the by-laws was amended, so that the dues should be as above stated.

The secretary also reported that the council recommend the re-election of the old officers with the following changes: In the place of the late Rear Admiral William T. Sampson, Mr. Stevenson Taylor as vice-president; Mr. A. P. Niblack and Mr. Henry G. Morse as members of the council in place of Mr. Stevenson Taylor and Mr. Edward Farmer. These recommendations of the council were unanimously adopted and the list of officers is as follows: *President,* Clement A. Griscom; *Vice-Presidents,* Francis T. Bowles, Charles H. Cramp, Frank L. Fernald, Philip Hichborn, Charles H. Loring, George W. Melville, George W. Quintard, Irving M. Scott, Edwin A. Stevens, Stevenson Taylor.

Members and Associate Members of the Council.—W. Irving Babcock, Washington L. Capps, French E. Chadwick, James E. Denton, George W. Dickie, William F. Durand, Nathaniel G. Herreshoff, Ira N. Hollis, William H. Jaques, John C. Kafer, Frank B. King, Frank E. Kirby, Walter M. McFarland, Jacob W. Miller, Henry G. Morse, A. P. Niblack, Lewis Nixon, Cecil H. Peabody, Walter A. Post, Harrington Putnam, Horace See, E. Platt Stratton, David W. Taylor, George E. Weed.

Executive Committee.—Francis T. Bowles, Harrington Putnam, Stevenson Taylor, Lewis Nixon, Edwin A. Stevens; Clement A. Griscom and W. L. Capps, *ex-officio.*

Secretary and Treasurer.—W. L. Capps.

Mr. Griscom when notified of his election said in part:

"On several previous occasions I have remonstrated with you for persisting in selecting a comparative layman for this high office, but I have none the less been keenly sensible of the honor conferred upon me and beg to thank you for it. At the time of the foundation of this Society, in 1893, the American mercantile marine was still struggling against adverse conditions, largely due to national apathy in all matters affecting our maritime prestige. It is to be hoped that our commercial necessities and a quickened public sentiment may serve as potential influences, until the mercantile marine of the United States may again attain that supremacy among the fleets of the world which was once the source of our greatest national pride. While we may well be proud of the development of our navy, we must not forget that the foundation of true naval strength lies in large merchant fleets, from which a war fleet can be recruited in times both of peace and war."

FIRST TECHNICAL SESSION.

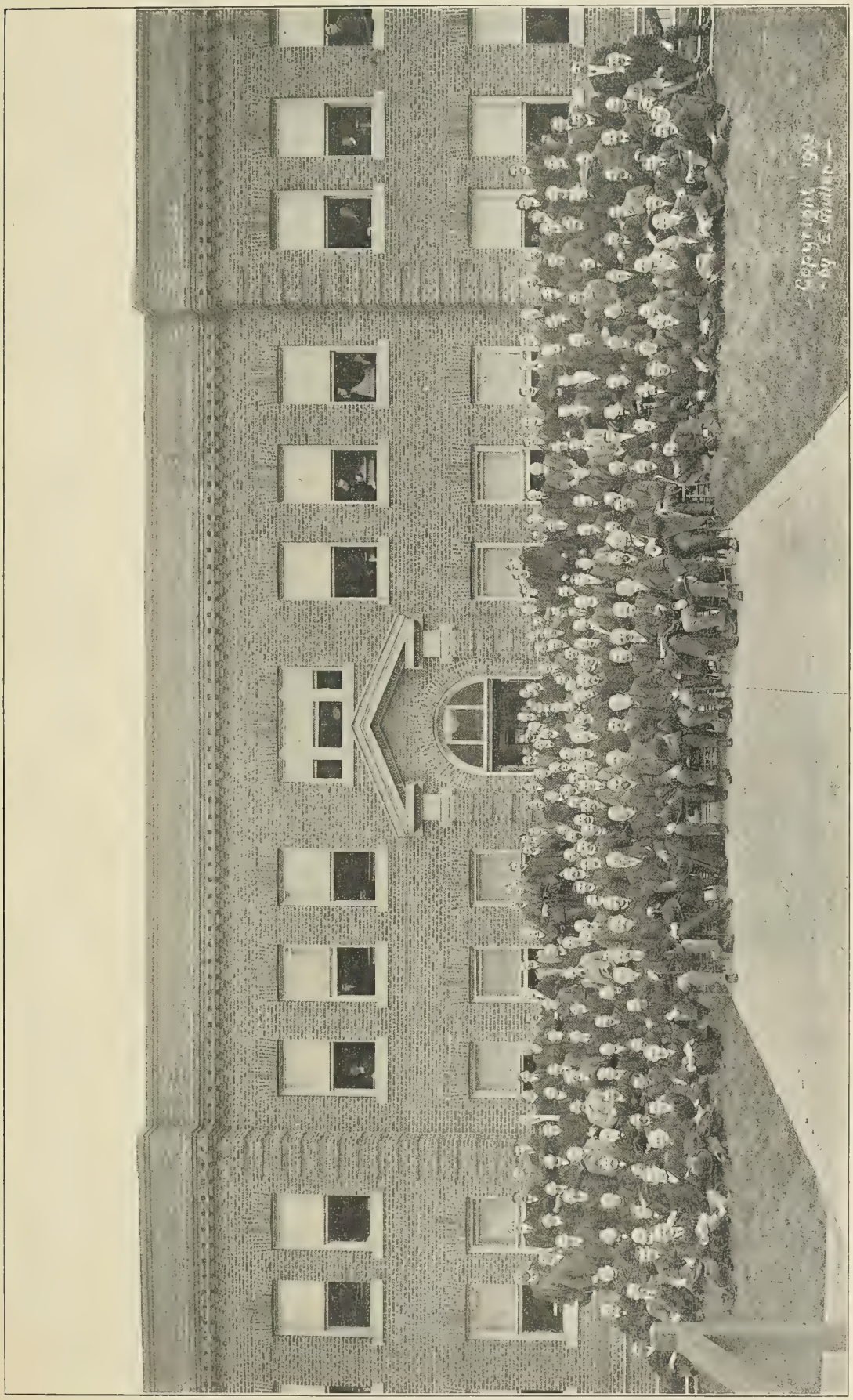
The technical session was opened with President Griscom in the chair. In the absence of the author the first paper on the programme was read by Secretary Capps.

TECHNICAL TRAINING FOR SHIPBUILDERS.

BY HENRY S. PRICHETT, LL.D.

Abstract.

This paper deals with the general problem of professional education for the shipbuilder, and in particular with the course of instruction offered at the Massachusetts Institute of Technology. The author discusses the relation between the general groundwork for such a course and the professional studies, and illustrates his points by reference to the course of study at the institution referred to.



GROUP OF MEMBERS OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS, TAKEN BEFORE THE ADMINISTRATION BUILDING, NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J., ON NOVEMBER 22, 1902.

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DISCUSSION.

PROFESSOR CECIL H. PEABODY: My attention has been called to the fact that in rehearsing the several things proposed undue attention seems to have been given to submarine boats and automobile torpedoes. The fault of this, if it exists, lies with myself; I did not appreciate that they were thrown into the apparent prominence which is given to them here. They are well recognized to be of secondary, though great, importance. This comes out especially in the schedule for the graduate year. The first two years, junior and senior, are now in operation and will be changed but little, except in such manner as may be required by the growth of any live school. The first two years are intended to cover, by lectures in naval architecture, substantially all of the accepted theoretical work, and perhaps it is not wise to go further into that.

PROFESSOR W. V. HOVGAARD: The work is in three sections. The first section is the real design work. That is laid out on very much the same lines that it was at the Naval College in Greenwich, but with this difference: In Greenwich we had two students on one design, while we give each student here his own independent design. The second section consists in a series of lectures, which begin with the history of the development of warships. It gives a history, both for coasters and for other important types of warships, and the relation of how the different steps in the development have been brought about. After the historical part, the next lectures will be on the theory of naval design. They are to contain a discussion of the general principles, for choosing and settling upon the elements of a design. The last part of the lectures will consist in the discussion of the structural arrangement of warships: comparing American, English, and French warships, in a general way. The lectures will be accompanied by a great number of compilations of data which we hope will be instructive and useful to the students hereafter. These lectures, as well as the structural lectures, are lined out much on the plan of the well-known book of M. Comeaux. The third section is to consist of visits to the shipyard. Thus I hope to give them a certain aptitude for the interpretation of working drawings, which I think cannot fail to be of value to them later on in life.

REAR ADMIRAL FRANCIS T. BOWLES: Without discussing the means or the methods of instruction set forth in this paper, I want to accept Dr. Peabody's apology for the undue prominence given to the submarine boat. That was hardly necessary, because the study of submarine boats, from a student's point of view, is probably one of the most intricate in the study of naval architecture. What this paper really intends to present is this: The Government of the United States, having been in the habit of sending its students abroad for instruction, has now concluded to instruct them in this country; and this paper is a notice to the profession of that fact, and also that we are quite willing to instruct other people.

NAVAL CONSTRUCTOR PAXTON: I have had special opportunity for following the work of young naval students, and I want to emphasize a little as to the practical work which they are doing, and bring out that each week these students perform manual labor in the shops—the juniors; and the seniors each week study shop management and shop administration. Thus we put them in touch with the workingmen, and they can understand the feelings of a good mechanic and know how to sympathize with him in his work—which is the work these students must direct in the future.

MR. W. G. FORBES: This paper is of very great interest to me, being on the New Jersey State Board of Education, and I want to emphasize one or two points which I think are touched upon here too lightly. In the delightful remarks of our president at the opening of the meeting to-day, he spoke about the facts of American shipbuilding. Now, there is nothing that will bring about American shipbuilding so much as having technical men in charge of the shops, in positions which to-day are always handed over to men of good mental ability, but who lack that technical training which is spoken of in this paper. Within this room there is a gentleman who took charge of my shop as its foreman. He was just such a technically trained man. It was perfectly marvellous, the difference that that young man made in that shop in a very short time. Now, it is to that style of man that we must look, who will assist us in making our merchant marine what it should be—the leading merchant marine of the world. Take a map of the world, and then take a blue lead pencil and mark the lines of great sailing vessels, and then with a red lead pencil mark the lines of those great steamships. It will look like the chart of the human body, with veins and arteries; but they almost all terminate in that little heart of a country—England. Let us impress upon those we come in contact with the value of this technical training, so that those lines will run to our country.

MR. W. H. JAQUES: I think perhaps this Society will accept the recognition of the influence of technical training which has permitted and fitted this country to take care of itself. I think there is no other member of this Society who will admit it more than Admiral Bowles, in the recognition of the foreign training which has permitted us and admitted us to the first place in the world of naval administration.

MR. STEVENSON TAYLOR: The necessity for this technical training is being shown in the institution of which I had the honor of being president, and the success with which the students who graduate annually from that institution obtain good positions. Unfortunately, none of you gentlemen can come to that institution because you are all too well off, as it was founded by the beneficence of one of the class so well spoken of in this paper, a shipbuilder, William H. West.

NAVAL CONSTRUCTOR WILLIAM H. VARNEY: I wish to add one thing to what has been said here. Some of the older members of this Society and some of our naval constructors recollect the day when our American wooden ships were the best ships there were in the world. We lost that prestige, but we are in hope that we will presently regain it. We lost it because foreign countries made a more technical study of shipbuilding than we did. But we are now regaining it, by taking advantage of what they have done, and then adding our American inventive genius to it, which enables us to go forward to success.

PROGRESSIVE TRIALS OF THE SCREW FERRYBOAT EDGEWATER.

BY EDWIN A. STEVENS, VICE-PRESIDENT, AND CHARLES P. PAULDING, JR.

Abstract.

The *Edgewater* is a screw ferryboat of the usual type with a screw at bow and stern.

This paper presents the results of three sets of trials as follows: (1) with one screw astern; (2) with the same screw ahead; (3) with both screws. The dimensions and characteristics of the boat are given together with the complete data taken on the various tests, and the results derived from this data are presented in graphical form. The speed-revolution curves given were worked up by the method described in a paper on "Tidal Corrections," which forms part of vol. vii. of the transactions of the Society of N. A. and M. E. The necessary descriptions regarding the method of reduction of the data are given, so that the entire work may be checked or such other use may be made of the data as might be desired. Naturally the results showed the best propulsive efficiency for a single screw working at the stern, next for both screws, and the poorest for the single screw working at the bow.

DISCUSSION.

MR. F. L. DU BOSQUE: This is a very interesting paper, particularly to those interested in ferryboat designs. It is very gratifying to see the low admiralty efficiency of this boat. I do not like to say that this boat seems to run on a ferry which permits of that low efficiency. Every trade has certain limitations which require certain amounts of data in different directions, and it seems very interesting, as a contribution to this paper, if the author could exclude those calculations in the discussion. It is well recognized that having a certain form of hull, which is limited in proportion to the ferry on which the boat is going to run, that very little gain can be obtained excepting by some improvement in propulsion. In a paper read before the Society in 1896, certain lines were suggested, I think, by which that gain could be obtained. As you are aware, these boats have a screw at each end, and the system is inefficient. In the case of the *Edgewater,* it appears that about 25 per cent. more power is required to run that boat at her usual speed with two screws in operation than with one screw pushing at the stern. It would seem quite desirable to save that 25 per cent. if possible. At the trial described on the ferryboat *Cincinnati,* experiments were made to try and overcome that loss of efficiency of the power of the screw. In the case of the *Cincinnati* it amounted to about 16 per cent. Since then a system has been put into effect which practically does overcome that loss. I would describe it by saying that it is simply by designing a wheel that has a very limited backing power. Some of the ferryboats around in the harbor are equipped with wheels very similar to those used on the fast torpedo boats, where the blades incline to a very considerable extent. It has been found that this type of wheel requires less power to propel with two screws in operation than it does with one screw in the stern.

MR. STEVENS: I wanted especially in preparing this paper to avoid any question of comparing different boats, because the custom on different lines cannot be compared. Taking the *Edgewater* and the *Cincinnati,* I may say that in the case of the *Edgewater* it was desired to obtain the speed because the company was unable to afford a large number of boats. Therefore, speed in crossing the river was the decided consideration; the team travel being comparatively light over that route, and therefore the load at the end of the boat comparatively small. These conditions were exactly reversed on the Cortlandt street ferry, where the *Cincinnati* was put on. She was designed with a very much harder shape and hull—a rather difficult design hull. At low speed, taking into consideration the fact that the boats were run by steam thirty per cent. of their actual time, the amount of saving was comparatively small. These facts are only given because in a case were a designer to go from first experience in these boats to any high-speed boat, these figures would become of some value. But I want to disavow any intention of having these figures taken at all as criticising other designs. What I wish to say is in regard to the figures quoted by Mr. Du Bosque, of 25 per cent. of power in using two screws over one screw; that is approximately the figure I have arrived at. The justification for the double screw arises from the fact that if you take the power necessary to drive a boat with a single screw ahead, the mean of that and the power for the single screw astern will be found higher than the power used for two screws. Of course, besides that there comes the fact of maintenance. The bow screw gives more handiness. stopping power, and control, and especially the saving of time in entering and leaving slips, allowing the boats to maintain their speed very much farther into a slip. The use of a screw with full backing power has, I understand, been followed with very decided gain in the case of the Pennsylvania ferryboats. I would call attention to the fact that most of the boats that I have had anything to do with previously have had screws designed to be equally efficient in both directions. Judging from these trials, I would consider that that which is only a small departure in the direction indicated by Mr. Du Bosque has given the result. Probably better result could be obtained with the wheel which he suggests, more of the Thornycroft type.

MR. DU BOSQUE: I had occasion to compare the screws of the *Edgewater* with a screw that we happened to have on the boat, and the result appears like this: The *Edgewater* now requires 520 horse power to propel the boat with 14 1-2 per cent. slip. In the comparison of the effective thrust it is necessary that the slip should be identical. A wheel with a similar effective thrust, 14 1-2 per cent. slip, will be propelled on the Thornycroft wheel with a saving of 65 horse power, or 18 per cent. I found that the admiralty coefficiency of the *Edgewater* was raised to 104 by the use of this wheel, which I consider to be extremely high for a ferryboat.

POSSIBLE AND FUTURE DEVELOPMENTS IN THE USE OF ELECTRICITY ON BOARD SHIPS.

BY F. O. BLACKWELL.

Abstract.

A comprehensive discussion of the different features of electrical machinery on shipboard is given by the

author under the three general subjects, substitution of steam turbine for reciprocating engines for driving electric generators, the use of alternating-current generators and motors of continuous-current apparatus, and the operation of all auxiliary machinery on ships by electric motors. Under the first heading the author believes that the steam turbine cannot be regarded as a general substitute for the reciprocating engine, as its speed is too high for direct connection to most machinery or for safe use of gearing; for the electrical drive, however, it is ideal. Compared with the reciprocating engines in slow-speed generators now in use, a turbine plant could be installed which would have but one-quarter the weight and take up but one-tenth the space. The efficiency is very high for the turbine at both full and partial loads, namely: about 20 pounds of steam per kilowatt hour at full load and 22 pounds at one-half load, in comparison with 30 to 50 pounds for reciprocating compound engines running at full load and 40 to 65 pounds at one-half load. Alternating-current systems, generators, motors, and wiring are discussed both in the matter of design and in application. The author believes that all auxiliaries, including the feed pump, circulating and air pump, should be driven by motors, thereby greatly reducing the steam consumption. A table is given showing the number of auxiliaries, with their rated and ordinary horse power, to be installed on the battleships *Connecticut* and *Louisiana,* and a plan is submitted whereby all this machinery might be driven by electricity. He would divide the electric power into two separate plants, each to contain two units of 300 Kw. each. The present plans call for two separate power plants each to contain four 100 Kw. units. The power required for lighting, searchlights, driving the turrets, steering engines, anchor windlass, hoists, blowers, and pumps is taken up in each individual case. In concluding the author would recommend for transmitting power the polyphase current, and the induction motor for constant speed, and that the steam turbine should be used for driving the generators.

DISCUSSION.

Admiral Bowles: It is a most interesting and timely paper, and the author is most certainly entitled to the thanks of the Society for the very clear manner in which his points have been made. I am entirely in favor of the extended use of all electrical auxiliaries on shipboard, and in the designs of the new battleships, the *Connecticut* and the *Louisiana,* all of the auxiliaries under my control are operated by electricity except the steering apparatus and the windlass. The Navy Department has begun the introduction of electrical steering gear, and has taken up the matter cautiously, feeling that the systems at present used are not entirely satisfactory. The point made by the author of the paper in regard to centrifugal pumps is an interesting one, and I believe in the *Connecticut* and in the *Louisiana* the first use is being made of the centrifugal pump for minor auxiliary purposes. I feel that there ought to be some doubt expressed as to the very extended use of centrifugal pumps, recommended by the author of the paper, because any person who has had to operate centrifugal pumps under circumstances where I may say life and death depended upon its operation is familiar with cases where the cussed thing wouldn't work, and nobody could find out what was the matter with it. I may also say that there are various influences which prevent the extension of the use of electricity for auxiliaries on shipboard. The chief engineer, for instance, is not generally in favor of electrical auxiliaries, because he cannot turn on the juice without asking permission, which he can readily do when he uses his own steam. That seems a trivial thing, but it is really of very great importance.

Mr. J. G. Winship: On the subject of auxiliaries, I have had some experience with the electrician or the designers of electrical machinery, and I have always found that the electricians preferred to use steam power for all their auxiliaries. We are in a position now to state that the centrifugal pump is going to be used more than it was. I have been quite surprised lately—and I have had considerable experience with pumps—in one of our factories to find that they were so far ahead with the centrifugal pump. For instance, the other day I asked for an estimate, or some data on a centrifugal fire pump, and with your permission I will read you the letter that I received:

"Referring to your recent inquiry in regard to fire pumps to handle approximately 3,000 gallons of water against a maximum pressure of 160 pounds, we would offer —— turbine pump, running at 450 revolutions per minute at a maximum pressure of 160 pounds, and 350 revolutions for a minimum of 100 pounds pressure."

I want to say, respecting the experience with centrifugal pumps, that we will not even stop at the air pump; some of the experiments have been made in our work where the pump used was an air pump, and it was quite a success. I think you will find that as we go along with the centrifugal pumps that they will be used more than ever.

Naval Constructor Varney: Some years ago, while superintending a small vessel, I ran into a little difficulty in reference to ventilating that vessel. I conceived the idea that electricity would be very beneficial and save a great deal of room. It would save long and large air ducts, by substituting a number of small electrical fans. I immediately ran against a snag, for I found that the electrical power being controlled by another department, they raised objection to it. That has been a great drawback in the substitution of electricity, as I have found. I believe that electricity could be used, and should be used largely in ventilating ships, and in other places, as far as possible. I see no difficulty in the ventilating system, because it would do away with these large air ducts, and would certainly save a great many steam pipes.

Lieutenant-Commander William P. White: Hardly enough importance seems to have been given to the matter of the turbine drive for main dynamos. The control of the compound engine that is installed on board ship is simple enough, but it is not simple in regard to the saving of steam. If a vessel is going into action, where the work on the motors to drive the ammunition hoists is going to be very intermittent, it will need at some times a great deal of steam and at other times very little, and it will be necessary to have all the dynamos, or the majority of them, running, and it will be just at that time when the call upon the engineer to drive his engines as fast as possible and use as much

steam as possible will take place. Now, if we can do something to limit the use of steam in driving the dynamos, we will make one step in advance in regard to the speed of the engine. The use of electricity in various parts of the ship, as far as I know, is not opposed by any officer or any set of officers, or by any bureau. It is simply a question of who controls the building of the motors and installing them. The matter of the method of using the current can be carried on with the present installation in regard to lighting, but of course will have to be changed in regard to the power. It will be simply a question of changing the wiring. But in designing the ship, in reference to the electric wiring, or if the electric wiring is going to be very extensively used, some consideration must be made for carrying the wires from the dynamo to the different parts of the ship. It is customary in some ships to carry them through the compartments that lie outboard and below the protected deck. It is so done in the open wiring in the *Kentucky* and in the *Kearsarge,* I believe, where they have the three-wire system. If those compartments should accidentally become flooded, or even if there was a slight collision, it would throw the entire electrical plant out of order on one side of the ship. We ought to make an allowance for that, by making a complete system on different sides of the ship. But it is not desirable to run the wires or to run the piping in the passageway immediately behind the armor, because any injuries to the armor will break up our electrical connection. For that reason there should be some arrangement made for carrying the pipes fore and aft of the amidship line. That could doubtless be done if the original design of the vessel was arranged in that way.

MR. WHEELER: In regard to this question of economy, I wish to say one thing: The reciprocating engine gets a pretty black eye in the United States Navy when it drives generators, and this arises from a condition that I do not think is generally known. The navy demands an engine that is practically one-third larger than is necessary. That is very detrimental to the economy sought. It also demands that that engine shall run under conditions of low pressures of steam and high pressures of steam.

The author of this paper did not speak much about the weights. Now, that and the application of electrical motors for the machinery is a very important matter on naval vessels. I had occasion recently to design a high-grade vacuum pump for use with steam turbines where they expect to get 28 1-2 inches. It was necessary to elaborate somewhat, but I found that the weight was more than double and the floor space two or three times as much as would be required by a reciprocating air pump. Speaking of the *Minneapolis* trial trips, I hardly think it is fair to quote, because it was a notorious fact that the auxiliaries of that ship were in a very bad condition and the selection of many of them would not be tolerated to-day. For instance, the dynamo engines were in such bad condition that upon repairing them they used exactly one-half the steam, and many of the auxiliaries were entirely ill-proportioned for their work for the best economy. In fact, there were many of the auxiliaries that could have been compounded with very good result. There is one thing that is going to be of great advantage to the steam turbine, and that is the doing away with oil. If we can adopt that motor for auxiliaries, pumps and otherwise, it will be a grand thing to do, although we are adapting ourselves to-day to run without oil. We ought to place the economy of these turbines a little better than they promise. I think the future for the steam turbine is very promising, especially in connection with rapid-running machinery like centrifugals.

NAVAL CONSTRUCTOR VARNEY: In the use of a centrifugal pump, the efficiency of the pump is much benefited by having it as low down as possible, even if it is running in the water itself. May I ask the author of the paper how that will work with an electrical motor near the water, where it is liable to become short-circuited or destroyed? I would like to know what the author of the paper thinks about that, and whether he has considered that subject.

MR. BLACKWELL: Of course motors are used very extensively for mining and for sunken pumps, which are liable to be submerged quite often. Such pumps are made entirely enclosed. However, we have made them so that with 50 or 100 pounds steam pressure they have worked without leaking. The only difficulty with them is that the heat radiated in them must be carried off, to keep the motor within safe lines. If it was entirely under water there would be no trouble with it; but in a sunken pump, where you are running part of the time in water, we have the motor of the pump water-jacketed, so that the water passes around the motor and goes out in the stand-pipe, and that keeps the motor cool and permits the use of an entirely enclosed motor.

SECOND TECHNICAL SESSION.

The session was opened at two o'clock with Admiral Bowles in the chair, and, in the absence of the author, the following paper was read in abstract by the secretary:

PRELIMINARY OFFICIAL TRIAL OF THE UNITED STATES BATTLESHIP MAINE.

BY ASST. NAVAL CONSTRUCTOR J. W. POWELL, MEMBER.

Abstract.

This paper contains the usual data of trials conducted by the Government, and also takes up the question of general hull ventilation. Thermometers were placed in all parts of the vessel and records made of the rise in temperature when under full power. Some interesting photographs, showing the wave forms, are appended, and an outline of the wave profile at 18 and 17 knots speed is given. In the reversing test it took but 9 seconds from full speed to stop the engines, and 5½ seconds from "stop" to "astern." From "stop" to "full speed astern," 57½ seconds. The third feature of the test consisted in the turning experiments, which showed very valuable results. The final test of the trial was made on the anchor windlass and anchor handling gear, which consisted in dropping the anchors in deep water, the starboard bower to 90 fathoms and the port bower to 60 fathoms, and hauling them both together. On the four-hour official trial the true speed for the first run was 17.772 knots, and for the second run 18.228 knots.

In the absence of the author the next paper was read by Mr. A. M. Main.

THE WATER-TUBE BOILER IN THE MERCHANT MARINE.

BY WILLIAM A. FAIRBURN, MEMBER.

Abstract.

This paper opens with a brief historical presentation of the evolution of the water-tube boiler from the earliest types to those of the present day. The author then takes up the discussion of features to be considered in the design of a water-tube boiler suitable for merchant vessels. These in his opinion may be stated under the following heads:

1. All tubes should be absolutely straight and of uniform length. They should be of seamless drawn steel or nickel steel, very uniform in quality, and as near non-corrosive as is possible, with a ratio of length to diameter not exceeding 30 diameters. These tubes should be submerged and be placed on an angle of about 10 degrees from the horizontal. The boiler should be sectional, with front and back headers, or a compound front header with circulating tubes within the generating tubes. The tubes should be not less than three inches diameter, more preferred, and have a thickness varying from No. 5 to No. 8 B.W.G., according to size and location.

2. The steam drum should be placed at the front of the boiler with its center square with the tubes. The water level should be at the center or a little below the center of the drum. The drum should be not smaller than 45 inches diameter when space permits. If back headers are fitted, the steam discharge to the drum should be horizontal and connect to the drum at the water level. The interior of the drum must be made accessible. No part of the drum should be exposed to the hot gases.

3. The headers should be of wrought steel. No cast metal should enter into the construction of any pressure part of the boiler. The proportioning of the relative areas of the headers, uptake and down-cast, determines the capacity of the boiler and regulates the circulation.

4. The water circulation must be active and positive, and follow a defined path. The more rapid the circulation of water over the heating surface, the greater the evaporation.

5. The furnace or combustion chamber should be high, at least three feet, so as to thoroughly mix the gases before coming in contact with the heating surface.

6. All parts of the boiler exposed to the gases or pressure, particularly the exterior and interior of tubes, should be accessible for cleaning and repairs. It is necessary to keep the outside of tubes free from soot and fine ashes, the latter being especially destructive when moisture, such as is obtained from an attempt to clean from the outside with a steam jet, is present. A boiler composed of tubes that can be drawn from the front for examination possesses great merit. Expanded joints are preferable in many ways, but the necessity of keeping a boiler clean is of vital importance.

7. The boiler should be easily drained without resorting to siphoning or the withdrawal of elements or individual tubes.

8. The headers should be of corrugated form, the tubes being staggered, with no straight paths for gases between the same.

9. There should be a mud drum or receptacle arranged for the reception by gravity of solid foreign matter separated from the feed water.

10. The path of the gases leaving the furnace or combustion chamber should be approximately square to the tubes, and such that all the heat possible is abstracted from said gases before they enter the uptake. Efficient baffling can only be determined by experiment, and the nature and extent of the baffling will vary for the various rates of combustion. Proper baffling with reasonably good firing will eliminate the criticism of high stack temperature.

11. The air supply to the fires and furnace must be ample, but not excessive. Air supplied under pressure over the fires from all four sides of the boiler may be found desirable. Distance between fire bars is of great importance. Hot-air supply and induced draft may be found exceedingly efficient for water-tube boilers.

12. The boiler should never be placed with steam drums forward and aft, and tubes athwartships, in any ocean-going vessel, or in any vessel navigating rough waters.

13. The boiler should be capable of being built in any well-equipped boiler shop. The parts should be simple and of uniform construction, with as few different parts as possible. A large number of spare parts to be constantly carried at sea is undesirable. The boiler should be built so that it can be readily repaired by the vessel's own staff, no extra skilled labor being necessary.

14. The boiler should have a large ratio of power to unit of floor space and volume.

15. The boiler must stand forcing and maintained severe service.

16. The casings should be air-tight, built of heavier material than is usually used, and well insulated throughout in a manner that will stand the test of time.

17. Dry steam must be generated and the steam should have free and unobstructed escape to a steam dome placed at the center of the drum, from which the dry pipe leads to the main steam pipe. No separators or reducing valves should be permitted having for their object the drying of steam.

18. The feed arrangements should be simple and require no elaborate automatic apparatus.

19. The steam should be generated at a pressure equal to the working pressure of the engines. The boiler must be suitable for high pressure.

20. No screwed connections should be exposed to the gases.

21. Economizers placed in the uptakes are very efficient, but their inaccessibility and great cost of upkeep do not warrant their adoption. The feed water must, however, be injected into the boiler at a very high temperature.

22. The use of induced draft and air heaters, permitting a low stack temperature, making the installation independent of climatic conditions and causing a cool fire room, is considered favorable for a marine water-tube boiler installation.

23. The pressure on feed lines should not exceed the boiler pressure, and the feed system should be such that the amount of air in water is reduced to a minimum.

24. Mechanical stokers or oil fuel will probably be

used, and great gains result from better combustion, more regular uniform heat, constant steam pressure, and the prevention of loss of heat caused by frequent opening of fire doors.

25. The boiler must have absolute freedom for expansion.

26. The boiler must respond quickly to any sudden or unusual demand for steam and carry a steady water level.

27. The weight of the boiler should show approximately the same relative advantage over the weight of Scotch boilers as the water-tube boilers discussed in this paper. The parts should be light and easy to handle.

28. The thermal efficiency of the boiler must be equal or superior to that of any fire-tube boiler tested by the same unprejudiced engineer under exactly similar conditions.

29. The boiler must be capable of showing good results when burning inferior coal.

30. A tube should be renewed or plugged without removing any other tube or pressure part, or cooling down the boiler, other than by blowing off the pressure. The component parts should be independent of one another, so that the removal and repairs of one part do not disturb other parts.

31. Sufficient water should be carried in the steam drum to give the boiler a period of about twenty minutes before the water in said drum is evaporated, provided the feed is shut off and the boiler continues steaming easy under the usual natural draft conditions, burning about fifteen pounds of coal per square foot of grate surface per hour.

32. The steam space in cubic feet should be about equivalent to the grate surface in square feet.

33. The ratio of heating surface to grate surface should be not more than 40 to 1, and possibly less for natural draft conditions.

34. Suitability for rapidly raising steam.

35. Must be capable of being built in large units, and if worked entirely from the front, or front and back, side battery construction may prove advantageous.

36. Should consist entirely of cylindrical components with spherical ends, all parts being self-sustaining without staying.

37. The cost should be no more than that of a Scotch boiler.

The author then considers in some detail various modern types of boilers relative to the various requirements as laid down, and concludes that the successful water-tube boiler of the future that will ultimately displace the Scotch boiler for deep-sea merchant work will be designed upon experience gleaned from the working of such boilers as the Niclausse and Babcock and Wilcox.

In connection with the discussion the various advantages and disadvantages of these types are presented in detail, and comparisons are made between the straight large-tube types and the cylindrical fire-tube type.

The subject of mechanical stokers is also discussed in its relation to the marine field, and its various advantages and disadvantages are pointed out. Similarly the subject of oil fuel is taken up and discussed with particular reference to its use in water-tube boilers. The paper is accompanied by a large number of plates illustrating various types of boilers, and in particular the Niclausse, and certain types of mechanical stokers.

DISCUSSION.

THE CHAIRMAN: Gentlemen, you are no doubt ready to support the Chair in congratulating the reader on the excellent abstract he has presented of this compendious paper. It also directs your attention to the excellent theories of 37 commandments to be followed by builders of water-tube boilers. No doubt the conclusion stated in the paper upon the various points will give rise to a very interesting discussion.

MR. A. H. RAYNAL: I have listened to the paper by Mr. Fairburn with great pleasure, and find it of much interest. The author has gone over the ground of the history of the water-tube boiler in a very admirable way, and has compiled data which are certainly of value. There can be no graver question before the naval architect or marine engineer than the determination of the proper installation of boiler power. A mistake in the selection of the right type of boiler has been fatal in many cases. The experience of the British navy, recently brought so prominently before the engineering world, shows the importance of this question. While the author carefully quotes a certain classification or grouping of types arranged by Bertin, although differing materially from those by other writers, he couples the Babcock and Wilcox and the Niclausse boilers so closely and so frequently in his paper that when one reaches the end of the paper there may be doubt in the mind of the reader which is which, and whether there is much, if any, difference between these two types; or if there is any, that it is of so small an amount as to be of very little importance. It is this feature of the paper to which, as an engineer somewhat acquainted with the history and the development of the water-tube boiler in the United States, I object. The statement is made: "The only large installations made in American steamships have been branded failures, Babcock and Wilcox boilers being condemned in one vessel and Belleville boilers in the other two." That there were two failures of the Belleville boilers is an accepted fact and need not be discussed here. The failure of the Babcock and Wilcox boilers, however, I would emphatically deny and would challenge the writer of the paper to bring proof of. It is true the Babcock and Wilcox boilers were taken out of the *Grande Duchesse,* but under what circumstances? It would have been worth a good deal to the engineering profession had the conditions been ventilated in court and the reason found why a battery of boilers that was installed to develop 5,600 H.P. and actually developed over 8,000 H.P. continuously from New York to Savannah should have been condemned. Their true history forms one of the grandest proofs of the safety and efficiency of the Babcock and Wilcox boiler. In paragraph 13, on page 4, the condition of repair by the vessel's own staff without extra skilled labor is certainly not fulfilled by the Niclausse boiler, while for all reasonable repairs it holds good with the Babcock and Wilcox boiler. A tube that is rolled into place can be readily cut out and replaced by common laborers, and this has even been done by firemen of the ship. I know of cases where the boilers of farm engines have been retubed by green

hands fresh from the farm, and I am even aware of cases where boilers were retubed by prison laborers who never had been inside of a boiler or had a boiler-maker's tool in their hands before. Paragraph 15 is a very important condition, referring to the absolute necessity for a boiler to be able to "stand forcing." With the little experience had with Niclausse boilers in warships so far, it may readily be asserted that the Niclausse boiler cannot stand forcing. Whenever attempts have been made to force the boilers they have become leaky and the economy has been impaired to such an extent as to cause almost a total failure. On the other hand, repeated experience with the Babcock and Wilcox boiler in our navy has proven that this type of boiler can stand forcing for a long time without any detrimental results. I have shown enough, I think, to prove that there is considerable difference between the Babcock and Wilcox and Niclausse boilers; enough to warrant me in asserting that they should not be classed together; enough to show that they do not belong to the same type. On page 14 the author speaks of the preference in the installation of boilers in favor of the Belleville and Niclausse boilers, and concludes that "the figures for the Babcock and Wilcox boilers are not as good as these boilers usually show." This assertion falls to the ground completely when it is considered that the Niclausse boilers cannot be placed athwartships on account of the roll of the ship. I assert that this question of installation is entirely one of skill of the designer, and it is a fallacy to so closely pack together boilers that their inspection and cleaning are jeopardized.

On page 24, paragraph 4, the author refers to the economy of water-tube boilers in general, and makes the statement that "the water-tube boiler is not at present as economical in continuous steaming as the best type of fire-tube boilers." I would emphatically deny the accuracy of this statement. Water-tube boilers have been proved to be economical, and in this respect they have only failed when improper baffling was arranged in them. We have definite proof that not only are the water-tube boilers as good in economy, when properly designed, but that they even are more economical than Scotch boilers. One of the most convincing proofs of this statement can be found from the data of the tests of the boiler for the U. S. S. *Cincinnati.* Not only was this boiler eminently economical in the trials ashore, but the almost phenomenal results of this ship on her late cruise have demonstrated that the same results are obtainable afloat as well as ashore, even when proper firing is handicapped by a complement of green firemen and under the severe exigencies of actual service requiring the ship to be ready for any emergency at a moment's notice. On this subject I would like to submit a few figures that I have not with me at the present time, but with your permission, Mr. Chairman, will submit later in writing for record.

The author's statement that "the boilers of Niclausse type are splendidly designed to take care of uneven expansion of tubes" is certainly correct; but it must be added in this connection that in their desire to emphasize this point, the designers have sacrificed more important points. Besides, it is a positive fact that this loudly-heralded disadvantage of water-tube boilers, that have tubes held at both ends, has caused no serious inconvenience in actual practice. If this type of boiler were unable to take care of the expansion of tubes the Babcock and Wilcox boiler could not exist to-day, instead of being a living example, nearly forty years of age, of the misconception and error of this alleged serious fatality.

The section on inclination of tubes and the relative efficiency of straight and staggered rows of tubes refer to the often-quoted experiments of Watt. Now, while Mr. Watt could lay down a great many essentials of how a water-tube boiler should be constructed, the fact remains that he never succeeded himself in building one that amounted to much; and the author referring in this paragraph to the advantage of staggered tubes against rows, showing on page 12 very clearly a perfect arrangement of staggering of tubes in Fig. 1, omits to state the fact that this method of staggering is not pursued in the construction of the Niclausse boiler of the present day. The tubes are not completely staggered, but leave almost a straight way between two adjoining elements, so that their claim of 18 per cent. saving would probably be reduced to 9 per cent., as the Niclausse boiler is only, if I may use the term, a half-staggered boiler. When the author speaks of the Babcock and Wilcox boiler and says: "Its defects can be practically summed up in one clause—difficulty in keeping clean," he gives the greatest possible praise to that type of boiler, for if this is the only objection that can be raised against the Babcock and Wilcox boiler, and its very existence to this day disproves the truth of this statement, there is nothing left but the conclusion that the Babcock and Wilcox boiler is one very close to perfection.

THE CHAIRMAN: Fortunately for the management of the Society, Mr. Raynal's train was late and he evidently had plenty of time coming here to read the paper through and prepare this very able discussion that he has presented to us. The Chair sees other gentlemen present who can doubtless add to the interest of this discussion.

MR. M. T. MOORE: I would like to ask if any one knows why the Belleville boilers were taken out of the steamships *Northwest* and *Northland.*

MR. R. L. NEWMAN: Being one of those unfortunately connected with the installation of that plant, I will say that the Belleville boilers were removed because of faulty circulation. We found that the second row of tubes would continually burst on the top side. The circulation was so defective that a steam blister would form on the tube and the top would split through local heating. That was the plain cause of those boilers coming out of those steamships. There is just one word which I would like to say in reference to Mr. Raynal's remarks. I remember some eight years ago reading Mr. MacFarland's paper on the subject with a great deal of interest, and investigating the tube boiler, so much so that I thought that boiler was the only boiler extant. It is true that the first cost of construction is somewhat expensive. It possesses one very great advantage, and that is the ability to remove one of the tubes and replace it, which I think no other water-tube boiler possesses to-day. I do not think it is a good boiler for forcing, however. For the mercantile marine, it strikes me that the boiler has one very good feature, and that is that it should be able to supply dry steam.

Member: Mr. Moore was asking the question why the Belleville boilers were taken out of the *Northland* and the *Northwest*. I would like to ask why, since these boats have been supplied with the Scotch boilers, they have not been as regular in their trips as in previous years. The *Northwest*, as I understand, has never made her time yet.

Mr. W. Irving Babcock: I have just returned to-day from the Great Lakes, and while there I met some friends on Lake Superior, and asked them this same question. I was given to understand that the Scotch boilers were not giving the power that they had expected to derive from them. Now, probably that may be due to the coal they use, but it is true that they are not able to run on the schedule they were intended to do.

Mr. Moore: I asked the question because I wanted to see if anybody thought as I did, and now that the question has been answered I see that they did think as I did. I made a trip three years ago from Buffalo to Duluth on either the *Northwest* or the *Northland*, and at nearly every port we stopped at we changed elements and firemen. When we got to Duluth they hoisted out about 12 or 15 elements—as they called them—and they were all split exactly as Mr. Newman has stated. The chief engineer told me that the only way that he could keep firemen when he left Buffalo was to give them knockout drops. Those tubes looked as if they were split open while red hot. They were perfectly clean inside and out. Those steamships at that time did not make their time by any means, and I think it would be impossible for them to do so.

Mr. Newman: I think on the lake that one season the Belleville boiler ran very successfully, and the season when it did run so successfully I understand they imported Spanish firemen and the engineer was a Scotchman. The trouble usually is, you see, that the firemen that they get up there on the lakes are a very inferior type of men. The Spanish firemen on the vessel on this occasion were not able to speak English, and they simply obeyed orders, they fired regularly and they fed regularly, and perhaps that is why the thing worked so successfully that season. One great trouble with the native firemen that they get up on the lakes is that they think they know all about firing and they won't take orders. Perhaps that is one reason why they have condemned boilers of the Belleville type in this country.

Mr. James G. Winship: Now, I can go back to the time when the naval vessel was filled full of boilers and third assistant engineers. But I must say that at that time the ship generally got there. The late transactions of the United States navy developed the fact that one ship out of the fleet made a trip of ten or fifteen thousand miles with steam up all the time and was ready for action. Some of the other ships, as the records show, were not in action and couldn't get in action. Now, the point is, if the Scotch boiler and the water-tube boiler can get a ship in action, then that is the kind of a boiler they want. I used to be in the transport service. The army had charge of us. If our ships were not ready, we were liable to be thrown out of service. When we were getting one thousand dollars a day, the owners held the crew responsible for getting there. The idea of boilers for a naval vessel or for a mercantile vessel is to have a boiler that is always ready.

Mr. Du Bosque: This paper seems to decide in favor of a proper water-tube boiler and the inference is for the mercantile marine. It is surprising, therefore, that the author of the paper, who has spent a great amount of time on the paper apparently, has not studied the mercantile side of the water-tube boiler. There probably are more small-tube boilers in the mercantile marine than large type of boilers, and, I might say, running very successfully. The limitations that he gives here are probably the reasons why he has not described the small-tube type. He takes exception to screw joints in contact with heat, and he speaks of muddy drums and of large drums that should be used, etc. There is no doubt that the small-tube boiler in service, in the mercantile marine, is successful, which fact would seem to throw aside the conclusion drawn in this paper. A little further on in the paper it is stated that some of the small-tube boilers are expensive to operate and that all are more expensive to operate than a shell boiler. We have had some six years' experience with water-tube boilers, and about three months ago I was called upon to make a comparison of the actual cost of the different types. We have probably four of the different types in service. The up-keep, as I may call it, of the water tube was less than half of the up-keep of the shell boiler.

The Chairman: Would the speaker give us some information upon the cost of operation? Does it take more firemen to maintain a plant of water-tube boilers?

Mr. Du Bosque: I think it requires more skill to operate a water-tube boiler. I hesitate to give any points on the economic side, because the purpose for which we are using water-tube boilers shows that they are decidedly more economical than shell boilers; but I do not consider that the same comparison would bear in continuous service. In the six years that we have had water-tube boilers, some of them have operated twenty hours a day for ten months in a year.

Mr. Raynal: In my desire not to keep you unduly, in the previous remarks that I made I forgot one thing. On page 26 of the paper the author states that the water-tube boiler requires great judgment and skill in its operation. Now, this statement is one of the many excellent ones made in the paper. I personally hold the belief that when water-tube boilers are better known by the firemen that have to handle them, or as well known by them as the Scotch boilers are to-day, then the so-called greater skill in operating will not be called for. It is a simple question of experience. Within the last fifty years we have not advanced in evaporation one-tenth. Our engine economy has been made better, but our evaporation capacity has not. If you want so many pounds of steam per hour you have to burn so many pounds of coal, which means so many square feet of grate, and that answers the Chairman's question. There are so many square feet of grate to be attended to. It depends a little bit upon the judgment of the designer. One will crowd his entire design in the grate, when he ought not to. Now, those are the conditions that so often confuse us. If I may be permitted another moment, I have with me some most important data on this very question. The economy of boilers, especially in re-

gard to navy purposes, has been lost sight of. When warships are designed they are designed for a maximum power, and the engineers are in the habit of saying, "We don't care anything about your economy." This question of economy is a most important one, because the rates of combustion vary so enormously. We read, for instance, the following data in the test of the *Cincinnati,* running all along from twenty pounds of coal burned per square foot of grate, up to sixty pounds. Then we read of one eleven pounds, etc., etc. What does it all mean? This question has disturbed me for a long time, and only a year or two ago when Professor Goss, of Purdue University, made some experiments with a locomotive boiler, using the rate of combustion from twenty to over one hundred, in a closed boiler, he produced a very uneven curve, and from that curve I dug out a formula.

MR. BABCOCK: In the tube boiler the economy depends entirely upon the amount of heating surface in the boiler, does it not?

MR. RAYNAL: To a certain extent. It should be stated as an effective heating surface. I found that every boiler has its own rate of evaporation.

MR. DU BOSQUE: Would a Babcock and Wilcox boiler, of the same amount of heating surface, burning twenty pounds of coal, show the same economy as a boiler burning forty pounds of coal?

MR. RAYNAL: Reduced to the same rate of evaporation, yes. I reduce it all to one rate of evaporation.

CHAIRMAN BOWLES: The point of economy and operation in the water-tube boiler has not yet been cleared up. In the navy they do not object to the introduction of greater skill in the fire room; the owner might. The naval architect, however, does object to the great increase in the number of the crew and in the amount of provisions and so on that they have to carry aboard ship. I invite Mr. Raynal to account for the large increase in the crews of naval vessels, which is laid at the door of the water-tube boiler.

MR. RAYNAL: Mr. Chairman, I am not sufficiently posted on the fact as to whether that is so or not.

MR. BABCOCK: On that point I think I can safely say that on the lakes the ships that have Babcock and Wilcox boilers have 50 per cent. more men than the other vessels.

CHAIRMAN BOWLES: That corresponds with the Chair's information.

MR. DU BOSQUE: I have experimented with 8,000 horse-power water-tube boilers, and I do not see how the fire-room force has been increased. We are operating on the ferryboats both with water-tube boilers and with cylindrical boilers, and exactly the same force is used on each of those boats. Therefore I cannot see any reason for the addition of 50 per cent. to the fire-room force by the use of the water-tube boiler, as has been suggested here. There is no more coal used for the water-tube boiler than for the cylindrical boiler. I think there are very few vessels of any size but what carry a water tender. A water tender can attend to a 2,000 water-tube boiler as easily as to a shell boiler.

MR. M. F. MOORE: The tendency of the times seems to be for everybody to do less work. I have fired a boiler, I know something about throwing coal, and I have seen the time when if a man couldn't handle seven tons of coal in a day he lost his job. But we cannot get a man to handle half that amount to-day, because the trade unions, and the other things that we are up against, won't allow it. If we had two furnaces to one boiler thirty years ago we were in luck; we often had only one furnace, and if you lost ten pounds of steam then you might as well get out on the deck when you came to one, because that was the end of you.

MR. RAYNAL: It occurs to me that on the question of economy I can cite a very good instance that has come to my notice recently. The cruiser *Cincinnati* had Scotch boilers. It was decided to change those to water-tube boilers, and they installed eight Babcock and Wilcox boilers. Immediately after the installation the ship was sent out. Since that time I have seen her log continuously, and I know it to be the fact that she makes 15.54 knots to-day on the same amount of coal burned where she formerly made only 10 knots. This is a ship that has the same propellers and the same low-pressure cylinder that she had before. The only change was that the size of the high-pressure cylinder was cut down considerably, and also that the intermediate was cut very little.

CHAIRMAN BOWLES: The Chairman's knowledge of this fact has been inferred from what the last speaker has said, and therefore the Chair feels obliged to state that the coal was not burned in the old boilers of the *Cincinnati,* but it was simply baked.

MR. NEWMAN: There is one point that Mr. Raynal has mentioned about the *Cincinnati* which I wish to refer to. In my opinion, the additional economy did not result directly from the type of boiler, except in so far as its ability to carry the high pressure of steam is concerned.

CHAIRMAN BOWLES: The Chair is perfectly aware that the comparison in regard to the *Cincinnati* has not the slightest bearing on the subject. The truth of the matter is that in the fire rooms of the *Cincinnati* it was utterly impossible to get enough fresh air to burn the coal, and it did not burn; it simply baked.

MR. BABCOCK: I do not rise to speak as an expert, but I want to say this, that whatever opinion any of us may have on the question of water-tube boilers or Scotch boilers, I think we must all recognize that Mr. Fairburn has collected a very large amount of data in his paper. I have taken some pains to get some additional memoranda in regard to the ships *Northwest* and *Northland,* to which he has referred in his paper. I am very glad to hear from Mr. Newman that there was one season at least when these steamers ran with some sort of satisfaction. The only way I can account for it is in the fact, as he says, that they imported Spanish firemen and a Scotch engineer, and I think they must have imported French water to put into the boilers. However, those boilers have been taken out and Scotch boilers have been put in. If you will refer to this paper you will see there is a table giving the particulars of the Scotch boilers originally proposed for those ships, and the Belleville boilers which were afterward put in. Now I have obtained from the manufacturers of the Scotch boilers these particulars: There were 10 Scotch boilers, 12½ feet in diameter, 11½ feet long, and three 38-inch furnaces in each, put into each ship. They carried 217 pounds steam pressure. The total grate

surface was 625 square feet; the total heating surface was 22,580 feet, making a ratio of 36.1. The weight, dry, including breechings and stacks, was 406 tons; wet, 513 tons. The indicated horse power was about the same, and it was stated to me that the ship used 1,150 tons of coal in making the trip from Buffalo to Chicago and return, with the old boilers, and with the new Scotch boilers, running on the same schedule time, used only 750 tons. One of the speakers has said that he did not see any reason why a greater force was needed in the fire room with the water-tube boilers. Well, perhaps they are not needed on the trip, but they certainly are needed in port to make joints.

MR. F. M. WHEELER: I quite agree with Mr. Babcock as to the time and pains that Mr. Fairburn has been at in writing this paper. There is really a very great deal in it for discussion. Personally I would like to speak about one or two points that are somewhat in my line. He speaks on page 5 of putting on to the pump so much labor as is provided under the Belleville system as being a great disadvantage. Now, in building feed pumps for these boilers we have to provide frequently for as high a pressure as 600 pounds. Of course, that means a test pressure of perhaps 700 or 900 pounds, according to the idea of the party who writes the specification. Therefore, doing away with regulating devices that were unreasonable, the pressure is very much to be desired, and I think it is very important, and I am very glad that the author of the paper has brought out that point so strongly. Then, again, he speaks of the oiling, etc. That is a good idea, and if it is possible to put such separators on the main exhaust pipe cylinders it would be a good thing, but of course that is almost prohibitory on account of the weight and the room. It is all very well to try and filter the grease out of the feed water, but I think we want to attack the other end of the problem first, and get it out of the steam.

MR. NEWMAN: Take the lubricators off.

MR. WHEELER: I am very glad you suggest that. We are trying to produce machinery to-day that will run without oil.

MR. BABCOCK: In speaking of the *Northwest* and the *Northland* I might have added that the boilers which they have put in now only take up about two-thirds of the space formerly occupied.

LONGITUDINAL BENDING STRESSES ON DAMAGED SHIPS.

BY GEORGE C. COOK, MEMBER.

Abstract.

This paper deals with the longitudinal stress developed in a ship when damaged so that loss of buoyancy is experienced due to the flooding of one or more compartments. Brief reference is first made to the conventional methods of computing such stress and of the scales which the author found convenient to use in the calculations for the illustration of the text. Five vessels are used as illustrations, ranging from the coal barge to the transatlantic cargo and passenger steamer, and these are assumed to have one or more compartments bilged, and the longitudinal bending moment developed is then investigated for various conditions—in smooth water, on the crest of a wave and in the hollow of a wave. For convenience the various results are arranged in tabular form and the author closes with some general conclusions based on the results thus developed. These are briefly that in vessels where the weight of the hull and machinery makes up the total displacement and the machinery weight is placed amidships, the result of a bilged amidship compartment is decidedly serious in both wave and still-water conditions. In the usual type of mercantile steamer there is more likely to be some reduction of stress when the vessel is bilged amidships in still water, and but slight increase when on the wave. The author believes that this question should receive consideration along with that of reserve buoyancy and stability in like conditions, and that such examination might lead to such changes in bulkhead spacing and compensating longitudinal girders as to promote the safety of vessels in such conditions.

DISCUSSION.

WILLIAM R. SATTLER: I would like to ask the author of the paper to add another column to that table showing the actual stress caused by these different bendings. In the last vessel that he cites there the stress of 123,000 feet a ton is nothing like the severest test. The maximum bending test is something over 300,000, if I remember rightly, when poised on the crest of a wave.

MR. COOK: I will say that I did not have the amidship sections there with these different vessels; but the statement is quite right that the maximum stress is below, even in the most severely damaged condition, the structural limit.

SURFACES OF BUOYANCY AND OF WATER LINES.

BY PROF. CECIL H. PEABODY, MEMBER OF COUNCIL.

Abstract.

The general problem of the floating body involves the discussion of the systems of forces which are developed by an inclination of the body about any conceivable axis. The usual elementary investigation relates to inclination about a longitudinal or transverse axis only. In such cases the path of the center of buoyancy for such inclination is a space curve which is usually projected on the plane of inclination. Similarly the continuous series of water lines cutting off a constant displacement will have an envelope known as the curve of flotation. In the more generalized problems these curves become surfaces and the problems relate to the space geometry of these surfaces and of their various sections. The special development of the geometry of these surfaces is due to French writers on naval architecture. The author's purpose in the present paper has been to present some of the more important problems relating to these surfaces, using methods which may be somewhat more familiar to those accustomed to English works on naval architecture.

As there was no discussion on this paper, the meeting was adjourned.

SECOND DAY'S PROCEEDINGS.

The fourth technical session was called to order at 10:30 A.M. with Col. Edwin A. Stevens in the chair. In the absence of the author of the first paper on the programme, the paper was read by Professor William F. Durand.

VIBRATIONS OF STEAMSHIPS, WITH SPECIAL REFERENCE TO THOSE OF THE SECOND AND HIGHER PERIODS.

BY REAR ADMIRAL GEORGE W. MELVILLE, U. S. N., VICE-PRESIDENT.

Abstract.

In this paper the purpose of the author is to discuss the importance of unbalanced inertia forces of the second and higher periods and of the vibrations which they may produce. The subject is dealt with under the following three heads: (1) Do important vibrations of second and higher periods occur? (2) Are the unbalanced forces of higher period in the four-crank engine important? (3) Are the forces of higher period sufficient to account for the vibrations of corresponding period? Regarding the first point the author refers to the recent investigations in the German navy, in connection with which a large number of diagrams, showing the vibrations existing at various parts of the ship, were obtained by special apparatus designed for the purpose. In order to intelligently interpret these diagrams the author first presents a series of diagrams resulting from various combinations of simple sinusoidal curves representing vibrations of varying amplitude and frequency. The comparison between the features of the resulting curves and their known constituents becomes thus an aid to the interpretation of the actual diagrams taken from the ship. These latter diagrams are then discussed and the conclusion reached that important vibrations of the second and higher orders are to be found in all cases furnished by the observations referred to above. The author then examines in detail the inertia forces developed by the engines of the *Deutschland* and shows that while they are balanced as perfectly as possible according to the Schlick system, nevertheless second- and fourth-period forces and moments of very considerable magnitude are developed. It is furthermore shown that with the ordinary spacing of cranks the fourth-order moments disappear, while the second-order moments and forces are substantially the same as for the Y.S.T. system. First-order forces and moments are, of course, not eliminated by this method, but the point of the comparison lies in the fact that the more complicated method of balancing is able to scarcely reduce the forces and moments of higher order, although it does eliminate those of the first order. Under the third heading the author discusses the relation between the disturbing force and the magnitude of the vibration which it may develop, and gives in tabular form the relative values of forces and moments which would serve to develop vibrations considered to be of "equal importance." The meaning of the term "equal importance" is defined as "vibrations for which the product of force by frequency is the same." The conclusion of this section of the paper is that forces of surprisingly small magnitude and of frequency higher than first order may be able to develop vibration of corresponding order, and of importance equal to those of the first order developed by much larger forces.

DISCUSSION.

A written discussion was presented by Naval Constructor D. W. Taylor.

Mr. W. L. Tobey: Mr. Chairman, I have understood that the vibration in vessels propelled by turbine wheels was very slight. If that is so, then that would support Admiral Melville's claim that the vibration due to the propeller would be disregarded.

Mr. R. L. Newman: I would suggest that if the propeller is made absolutely perfect, then there are no unbalanced forces.

Professor Durand: To anticipate any further reply I would say that on one occasion there were certain vibrations, more especially prominent at the stern, mostly of a transverse character. The statement was made in that connection that a careful measurement of the propellers had shown a certain definite and rather large lack of uniformity in the pitch, apparently quite sufficient to give some color to the assumption that such transverse vibration might have been due to the influence of the propeller. Even so, they were not serious; but such as they were it seemed more likely to relate them to a lack of uniformity of pitch rather than any other cause.

Mr. Tobey: The vibration might have been influenced by the rudder.

Professor Durand: The author of the paper quite agrees, I think, with Mr. Taylor, regarding the relative importance of balancing one set of forces and two sets of forces; that is to say, in regard to Table A, the author did not intend to imply that a lack of balancing on the part of the primary force was permissible, but to show that with the cranks arranged as in the usual way, while there would be introduced certain forces and moments of the first period, which were entirely absent under the Yarrow-Schlick-Tweedy system, those which were there by developing the second moment were sensibly no larger than those under the Y.S.T. system. In other words, that under either system of balancing, the secondary force and moments were very large and therefore presumably culpable for any of the vibrations of the second period which might be observed.

Admiral Bowles: I hope that it is not out of order to point out at this stage of the discussion that the intimation of the last speaker, that Naval Constructor Taylor and the author of this paper are in entire agreement on fundamentals, does not seem to me to be borne out by the remarks of Mr. Taylor at all. It looks as if the author of this paper would be required to write another paper to clear the matter up.

Mr. W. E. Kimball: I would like to state, speaking of propellers, that in the last trials of the *Lawrence*, the standardization trials of the *Lawrence*, they used a uniform pitched propeller, and on the standardization runs there were very perceptible vibrations which undoubtedly came from that propeller, even though they balanced it to their best ability and got the true pitch there. There is no way by which it does not have an effect on the vibration.

Chairman Stevens: Was the pitch actually measured in the propeller itself?

Mr. Kimball: Yes, sir. The propeller was cast, and then they used a spiral, and it was cut true to the spiral and very carefully balanced afterward. I think the propeller, from the measurements, showed that it was about as true to the true pitch as possible.

Admiral Bowles: I might add this. One speaker has alluded to the fact that if the propeller was made absolutely perfect the vibration which it gives to the

structure of the vessel might be eliminated. I will assume that if the propeller were made absolutely perfect and then run in water of infinite depth, and not in the vicinity of any structure like a vessel, it probably would not vibrate, nor would it cause vibration. But when it is run near the surface of the water, and in the stream line motions caused by the motion of the vessel, and also contiguous to stress supporting the rudder, shafting, and the hull, it will undoubtedly give rise to vibration no matter how perfect it may be.

MR. H. A. SWANTON: The engines of the torpedo-boat destroyers built and just completed at Sparrows Point are, as doubtless most of you know, of the four-cylinder type. The low-pressure cylinders are at the ends, with the high and intermediate placed between them. The two air pumps are worked from beams attached to the crossheads of the two middle or smallest cylinders. When balancing up these engines, Mr. John McAvoy, who made the calculations, claimed that, although when the engine is standing still the air pumps may partially balance the piston, piston rod, etc., nevertheless, when it is moving, the inertia of the air pump is added to, instead of subtracted from, that of the reciprocating parts to which it is attached. This is contrary to the general practice of working the air pump from the largest cylinder, and also contrary to the rules given by Naval Constructor Taylor in Appendix B of his paper of last year. These engines were balanced up according to this principle, and the reports I have heard of the behavior of these boats seem to prove this claim. I regret very much that I cannot speak from actual experience, but I have been told that there was very little vibration noticed, particularly at the highest speed, which was attained with about 330 revolutions or over 1,200 feet piston speed. If the engines were out of balance to the extent of twice the weight of the air pumps and gear, it would seem as if considerable vibration should have been noticed at this speed, although, of course, if the time of vibration of the hull was enough different from the time of the vibrations produced by the engines no bad effect might have been observed.

Judging from this, it would seem that the usual custom of working the air pump from the low-pressure crosshead was wrong and that a balance sufficient for all practical purposes of the ordinary triple engine might be attained by making the low-pressure piston as light as possible, with the intermediate of the same weight, and then working the air pump from the high-pressure crosshead, so proportioning the weights with the lengths of the beam that the resulting effect of the reciprocating parts would be equal to that of either of the other cylinders.

In the absence of the author the next paper was read by Mr. Forbes.

THE DEVELOPMENT OF MODERN ARMOR AND ORDNANCE IN THE UNITED STATES.

BY REAR ADMIRAL CHARLES O'NEIL, U. S. N.

Abstract.

This paper, from its title, is largely historical and presents a most interesting description of the development of ordnance and armor during the last forty years. Particular reference is made to the more recent developments beginning in 1883. Comparisons are made between successive types of guns of the same calibre, showing the advancement in the weight of powder charge and in initial velocity and energy of the shell. Reference is also made to the development of smokeless powder, special types of armor-piercing shells, and other items of naval armament. The second principal division of the paper relates to the history of the development of armor, in particular from 1888 to the present time. The paper closes with a list of vessels of the navy carrying armor, and showing the character of armor fitted.

DISCUSSION.

MR. HOVGAARD: I think it might be added to what the author has stated in the paper, that it was really the introduction of the explosive shell more than anything else, perhaps, that forced the adoption of armor.

MR. FORBES: This paper is most interesting, and I want to add some little matters of history. I find that the first cannon in the United States was cast in 1647, in Lynn, Mass., by Henry Leonard. In 1648 brass cannon were cast in Bridgewater, by the Orr foundry. In 1775 18-pounders seemed to be about the largest guns cast on American soil. They got so proficient in them that in 1776 they cast one a day at the Joy Foundry in Reading, Pa. At this time a man by the name of Clapp got up a machine for boring cannon, and a committee of safety, of the State of Massachusetts, agreed to buy it if the Mr. Orr, before referred to, considered it good. I should, therefore, judge that before that date no bored cannon were used. In 1794 General Knox, Secretary of War, contracted with the Hope Furnace for 22-pounders at $106.66 per ton. In 1795 Secretary of War Fickens contracted for cannon at the following prices, which may prove interesting here: 22-pounders, $420; 24-pounders, $350; 18-pounders, $318; 12-pounders, $211; 9-pounders, $140; 6-pounders, $130. In 1790 William Denning made a cannon of wrought-iron staves, hooped around with iron—and this I find is about the first record of any built-up cannon—and the material was staves brought from the Tower of London. In 1815 Col. Bomford, of the Ordnance Corps, contracted with R. L. Stevens for elongated shells made by a secret process. I understand that although the name of Robert L. Stevens is connected with these shells, it was not he who was the inventor, but Mr. E. A. Stevens, the father of our chairman this morning, who was the original inventor, and the shop where I now do business was the point of ground from which the first one of these shells was fired. In 1812 the Bureau of Ordnance was established. Now, this is something which I wish to close my remarks with, and I think it is very interesting. In 1811 a committee of Congress reported that the founders in the various States had arrived at a perfection in the art of boring cannon, it being so well understood that our inspector of artillery has declared to the board that he never was compelled to reject a single gun on account of a defect in the bore, although he has examined over 2,000. This goes to show that there has not only been a great change in the artillery, but in the inspectors too.

CHAIRMAN STEVENS: The Chair would call attention to the great value to the Society of recording historical data of this nature. Many of these facts would have been very difficult to get at by the ordinary member,

and such a paper forms a very valuable addition to the records of the Society. The Chair would, therefore, feel that the usual vote of thanks to Admiral O'Neil be given with very marked emphasis.

REMARKS ON THE NEW DESIGNS FOR NAVAL VESSELS.

BY REAR ADMIRAL FRANCIS T. BOWLES, U. S. N., VICE-PRESIDENT.

Abstract.

In the preparation of the recent designs for the battleships of the *Connecticut* class and the armored cruisers of the *Tennessee* class, consideration has been given to the matters affecting the time required for completion. Of the ten completed battleships of our navy the average time required from the date of contract until the date of first commission has been four years eight months. One of the causes of delay, which it is possible for the navy to remedy, is the insufficient number of plans issued to the contractor by the Government. In these new ships there are no less than twenty-one contract plans given out by the department, and the specifications have been arranged in a logical order and made in all particulars definite and conclusive. Another feature which it is expected will reduce the time of construction is that all the plates and shapes entering in the steel structure are of commercial sizes. Many special features are found in the design of the new battleships and cruisers, chief of which is the increased displacement. In comparison with the *Maine* class, in the new *Connecticut* class the displacement is increased 33 per cent., resulting in an increased weight of discharge in all guns above six-pounders of 47.9 per cent., and the weight devoted to protection is increased 44 per cent. Other very interesting comparisons are made with the *Oregon* and *Kearsarge* classes, and discussing the *Tennessee* class of cruisers. Comparison is made with the *Pennsylvania* class, where an additional weight of 29.7 per cent. of guns and ammunition is given, producing an increase in the weight of one discharge of battery of 47.7 per cent. The speed of the two types will be the same, namely, 22 knots. A few of the principal dimensions of the battleships 18 and 19, namely, the *Connecticut* and *Louisiana,* are as follows:

Length over all	456 ft. 4 ins.
Length on L. W. L.	450 "
Breadth, extreme	76 " 10 "
Mean draft to L. W. L.	24 " 6 "
Displacement to L. W. L.	16,000 tons.
Freeboard, minimum, at full load forward	18 ft. 2 ins.
Freeboard, minimum, at full load aft	17 " 9 "
Normal coal	900 tons.

Engines, No. 2; type, vertical triple expansion.
Diameter cylinders: H.P., 32 1-2 ins.; I.P., 53 ins.; L.P., two of 61 ins.
Stroke, 48 ins.

Boilers, No. 12; type, Babcock and Wilcox.

G. S. total	1,100 sq. ft.
H. S. "	46,750 " "

Steam pressure, designed, 250 lbs. at engines, 265 lbs. at boilers.

Designed speed	18 knots.
I. H. P.	16,500

ORDNANCE.

Main Battery	Four	12-inch B.L.R.	40 cal.
	Eight	8-inch " "	"
	Twelve	7-inch R.F.	45 "

PROTECTION.

Armor:
Water-line belt, top, 11 ins.; bottom, 9 ins.;; decreasing to 9, 7, 5, 4 ins.
Upper casemate, 7 ins.; lower casemate, 6 ins.
Upper athwartship, 7 ins.; lower athwartship, 6 ins.
Barbettes..... { 12, 10 and 7 1-2 ins. / 8, 6 and 4 ins.; sponson, 2 ins.
Turrets..... { 12—12 ins. and 8 ins. / 8— 6 1-2 ins. and 6 ins.; diagonal, none.

Particulars are also given of the new armored cruisers No. 10 and 11, namely, the *Tennessee* and *Washington,* and plates of the general arrangements of both ships are included.

DISCUSSION.

MR. HOVGAARD: I think the Navy Department is to be congratulated on the design of the new type of large cruisers. There are two principles regarding the mounting of guns which I think are generally accepted by naval officers and others. One is that the best gun position should be utilized by placing the heaviest guns in those positions, or else placing twin mountings of the same guns on either side of the vessel. The second principle is that the gun ought to be given a protection which bears a certain proportion to the importance of the gun. The gun placed in the most important position should be most carefully protected for that reason. I think it is interesting to see how these principles are followed out in the vessels. I refer more particularly to the *St. Louis* and *Pennsylvania* class. In the *St. Louis* class we have a ship of 9,800 tons, carrying fourteen six-inch guns. Of these, two guns are placed in the end position, and these guns are protected only by the sheath. The other six-inch guns, facing the broadside, are given four-inch armor. If we compare these with the same class of guns in the English navy we find that these ships carry in each end position twin turrets mounting six-inch guns. These twin turrets are protected by five-inch armor, and all the other guns are protected by four-inch armor. Their ships have the same displacement as the *St. Louis,* fourteen-inch guns, and 22,000 horse power as against the *St. Louis'* 21,000. In the *Pennsylvania* designs we find the two ten-inch guns at each end protected by the turret hoods, and by barbettes carried right down to the protected deck and enclosing the whole substructure and mechanism of the gun. If we compare these with the same class in the British navy, which is a very good comparison, because that is 14,100 tons as against the new design 14,500 tons, they carry sixteen six-inch guns, the same as the new design of ours, and they carry at the end two ten-inch guns. So the difference is in the principles which have been utilized in our two ships. The length of these vessels is practically the same, 500 feet. The speed only differs by one knot. I think these new armored cruisers may probably be called cruiser destroyers. The great swarms of protected cruisers which exist at the present time, in all navies, will find their most dangerous enemy in these new vessels of ours.

MR. W. C. DOBSON: There is one point, perhaps, where it seems to me that the admiral has been at fault to support his gun turrets rather more than of the necessity caused by the use of the Babcock and Wilcox boiler. However, there is only one point where I can see where any saving could be made in the disposition of the weight.

Mr. Henning: Admiral Bowles in the reading of his paper inserted a little remark which does not appear in the print, which might be of interest to the members. He made the statement that it was not easily possible to compare the relative cost of ships of the same size of those built abroad and those built here. He recurred to the cost of armament and said that that was an unknown quantity. Now, I recently had a little experience in trying to get some material that was ready in the gunshops of two of the largest works of this country and which was exactly in line with gun work. I wanted to purchase steel of the same kind used in the guns, and the quality I wanted was of the highest order. When I got my estimate from two of the largest shops in this country the cost was $23,600 per ton. That, of course, made the work I wanted done prohibitive. So I went to Crookes and I got exactly the same work, delivered in two-thirds of the time, for $6,680 per ton. There was not a ton of material in what I wanted, but I had to pay that rate for it. I think that explains why we cannot make any comparison in the cost of armament between foreign ships and ships built here.

Chairman Durand: I think the Society is to be congratulated on the fact that Admiral Bowles has not lost interest in the Society, and that he has been able to turn aside from his duties in Washington and present this paper before us.

WHY IT TAKES SO LONG A TIME TO BUILD AND EQUIP A NAVAL VESSEL FOR THE UNITED STATES.

by George W. Dickie, Member of Council.

Abstract.

In this paper the author, while not desiring to find fault with the present system of producing naval vessels by contract, points out the chief causes of delay in building these vessels, the most important of which is the habit which has hitherto prevailed of designing the vessels while they are under construction. The plans, which are made by the contractor, are first criticised by the superintending constructor, and possibly returned several times for changes before the latter submits them to the bureau at Washington. There they may be entirely rejected, in which case the contractor must draw them over again. To expedite matters the design should be completed before the contract is signed, giving location and dimensions of every compartment, dimensions of armor plate, the question of armor and armament should be definitely decided upon, and the magazines should be worked out in considerable detail. All arrangements of machinery should be shown, and allowances made for the space taken up by bulkhead stiffeners in laying out the plans. The drainage and ventilation system should also be part of the original design. Many of these points the author understands will be embodied in the new contracts. The comparison is made between the Bureaus of Construction and Repair and Steam Engineering in favor of the latter. It is recommended that the builder should prepare his plans as he thinks would best carry out the requirements of the specifications, and submit these to the bureau through the superintending constructor, who would give the bureau his opinion and recommendations in regard to them. Thus the drafting and designing work of the latter would be abandoned. In the opinion of the writer the naval constructor should not be the naval architect; neither should he be the shipbuilder, unless in the first case he is responsible for the design, and in the other he is to find out the wherewithal to meet the obligations of the payroll. The author closes with the statement that his criticisms are in reference to the system and not against the naval constructor.

DISCUSSION.

Mr. R. C. Monteagle: Mr. Chairman and gentlemen, it seems a matter of regret that a member of this Society should have made such invidious comparisons between the methods and men of the two great naval departments of the country. These comparisons are none the less invidious that they are coated with sugar. Stripped of all verbiage, Mr. Dickie's paper is an attack, and to make his object entirely beyond doubt he compares the methods of the two bureaus. The old proverb that "comparisons are odious" never was more fitly illustrated. My quota of experience with naval constructors is that they simply require "the result to be attained" and do not attempt to force their methods on the contractor, supposing their methods to be at variance. Any contractor who yields to an inspector of machinery or construction, in the matter of methods of doing work, does so by his own choice. He is not obliged to do so by any law nor custom. In regard to the use of material which has not been tested, in places where there is no severe strain, all that is necessary in such a case is to get permission from the inspector to use such material, and I have never known an inspector who would refuse to do so in a reasonable case.

Admiral Bowles: I presume I am expected to say something on this paper. First, I want to acquit Mr. Dickie, the author of the paper, of any collusion with me in the preparation of this paper. Just imagine the dismay of the author of the paper and of some others if I were to reveal the secrets of my position to members and tell what I know about contractors. Now, it might be well to examine for a moment how people inspect their vessels who pay for them out of their own pocket. Do they rest with the inspection of their most distinguished captains, commodores, or whatever they may be? As a matter of fact, the inspection of the hull is conducted by the registration societies, men who have spent their lives in technical study of their profession practically and theoretically. Not only that, but the great steamship lines maintain a technical staff of their own, principally devoted, however, to the inspection of machinery. We have been building battleships only for a period of about ten years, and it was not wise in the preparation of the original designs to go into them in detail, when the problems to be worked out were to be guided by conditions which had not been developed. That, however, now is practicable and has been followed out in the most recent designs. The variable conditions have been eliminated as far as practicable, and will continue to be, more and more definitely. The Navy Department, however, pursues practically the same course with regard to the carrying out of its contracts that other people do, and nothing

more. It is not necessary to tell you that contractors as well as constructors in the navy are human. In regard to the author's complaint, I think that a sufficient reply to him is simply to say that it is well known that the firm with which he is connected has built some very successful ships. One of them steamed around the Horn. Now, if the author is willing to share with the navy constructors a proportion of the credit which he assigns to them in his paper, I am quite satisfied.

A somewhat animated personal discussion between two of the members here took place, owing to an attack of the first speaker on our navy's methods of drawing specifications and superintending work, in comparison to Lloyds' and the British Admiralty's systems of conducting this work. In the rejoinder the second speaker authoritatively stated that the specifications of the British Admiralty are far more vague to-day than ours ever have been; they leave everything practically to be settled at some future time, and their inspection is by no means equal to ours in any respect whatever. There is no comparison between the perfection of detail upon our vessels, with regard to military power and adaptability, and those of the English navy; and controversies can be pointed to which have existed between shipbuilders and the Lloyds' Registry over a series of twenty years, of violent discussions as to who shall control the design of vessels.

A written discussion prepared by Naval Constructor Cawresey, stationed at the Union Iron Works, was here read and the meeting afterward adjourned until 2 P.M.

FOURTH SESSION.

Upon the meeting being called to order by the Chair the adjourned discussion on Mr. Dickie's paper was taken up.

MR. W. C. DOBSON: I refrained this morning from taking any part in the discussion, thinking that my honored chief, Mr. Charles H. Cramp, would be here and present his views in his own manner. I regret, however, that I am in receipt of a telegram from him stating that he is too ill to be present at the meeting, and wishing me to apologize to the members for his absence. I regret that Mr. Dickie has seen fit to take a view of the relation existing between the superintending constructors and the contractors in matters of opinion which arise between them, for it gives me particular pleasure to bear testimony to the very amicable relations existing between the superintending constructor and his assistants and our own people. It is only by the hearty co-operation of the superintending constructors that we have been enabled to turn out such products of excellent merit as the report in the morning newspapers of to-day seems to indicate in the case of the *Alabama* and the *Massachusetts*. I have always found, in my experience with the superintending constructor and assistants in our yard, that whenever we have a plain, straightforward, and square proposition to submit to them we are always met more than half way, and that we have nothing whatever to complain of in respect to treatment at their hands.

CAPTAIN LAWRENCE Y. SPEAR: I would like to speak regarding the number of times that the working plans passed between the contractor and the superintending constructor before the latter was ready to sign them. Now, I have found that the contractor, being busy, oftentimes depended upon the superintending constructor to keep many of his plans straight for him. The plans were sent in such a condition that they required an immense amount of checking up, and the time so spent was ultimately saved in the building of the ship. A number of times I have had the contractor, when I was on the other side of the fence, admit that fact. But I think that in a number of cases there is a little injustice on both sides. I think a number of times there have been delays on the part of the naval constructors. One of these is because it has been the case for five or six years that most of the constructors are supposed to be in four or five different places at one and the same time. Again, we all know that there has been an enormous demand for competent draftsmen, and we have all had to put up, on both sides of the fence, with somewhat inadequate help. The result has been that the contractor has sent out improper plans. The result, on the other side, has been that an undue amount of time has been devoted to correcting those plans. So that, all things considered, I think that the delay on both sides about evens up. The personal equation of both the superintending constructor and the representative of the contractor is a most important element in the whole thing. If a contractor when he begins work consults the superintending constructor, and if the latter will consult with the contractor, get in the drawing room together, why, a great deal of the trouble will disappear. But the trouble has been that by the time the plan reaches the superintending constructor it is generally in such a shape that he cannot approve it without trouble. One of the reasons why that cannot always be done is because the superintending constructor has had, as I have said before, so many things to attend to.

LIEUTENANT COMMANDER H. C. WHITE: There was some reflection in the past about an old sea dog inspecting a ship. Now, I don't know but there may be an old sea dog inspecting ships to-day, but I have not seen many of them. Certainly, the officers who are the inspectors of equipment and ordnance are very far from being as old as they might be. The work of installing electrical equipment on board ships of war has been worked out by officers of the navy. It is the experience of those officers in the use of electricity on shipboard, and the repairs of the electrical plant after the ships have returned from voyages, that have brought about the changes in the specifications which are noted by Mr. Dickie. If we did not change our specifications from time to time as the requirements dictated, we should be very slow in our progress. Now, the one point in regard to the inspection of ships is the line officers who are detailed in the yard; they have no part in the construction work at all, and there never has been any attempt or any desire on their part to interfere or to criticise the technical part of the work. There are details which come under the officer's experience on board ship, the arrangement of the compartments and the arrangement of the ship, which might very well be referred to the officers who serve on the ships. The demand on an officer's time for the inspection of the

crew and for the necessary work that he has to do, gives him very little opportunity—unless he takes it at odd hours, the hours when other people are enjoying themselves—to learn about the ship. The condition of the ship after they have been on cruises from three to six years depends entirely on the care with which the officers of the ship make their inspection and the knowledge that they have of the structural make-up of the ship. There are very few line officers who are available for duty of that kind on shore, and it is in my opinion a very important point in an officer's education.

MR. DU BOSQUE: The writer speaks of the interference of naval constructors in the methods of construction, and in the matter of design, and of adherence to standards. Of the first cause I think that the constructors to-day are perfectly excusable, because if there is any interference it has come to them as a sort of an inheritance. We can probably all remember that when the upbuilding of the navy was commenced, in 1882, the initiative was taken by the constructive corps. I might say that some of the shipbuilders looked upon the designs submitted to them by the constructive corps with exceeding doubt, thinking that they would not be strong enough to do the work intended. After the contracts were placed the shipyards were very glad, however, to avail themselves of the knowledge that the constructive corps had gained by its representatives abroad. They were also very glad to adopt these recommendations from the constructors as to the kind of tools that should be used in the manufacture of this new style of ship, and I am sure that some of the most important yards in the country to-day can trace their early progress to the advantage that they have obtained from the young constructors in this country. As to the matter of standards, it is quite surprising that the navy has not progressed faster than it has in regard to the adoption of standards. The navy has a great number of units afloat on vessels that contain a great number of working parts which are very apt to break down. It seems very essential, especially to the navy, that standards for these fittings should be adopted, and I can only point to the different transportation companies that find to-day that it would be almost impossible to conduct their business successfully if the numerous parts that go to make up the machinery that they use in operation were not made standard.

MR. A. G. RUTHERFORD: Although I sympathize in some particulars with Mr. Dickie in his troubles, yet I hardly think that he has made out a clear case as to why it takes so long to build a war vessel. I think there are two important points which contribute to the loss of time, which he has not mentioned in the paper, and I believe they are points which are not in the minds of the gentlemen here present. One is the poor delivery of material. I refer now particularly to structural steel. There are few manufacturers of material who are so ignorant of the material that they have to furnish as those who are engaged in steel production. Why, we often get bulkhead stiffeners supplied to us before we get parts of the framework, and not infrequently I have known owners to send a practical man to remain at the steel plant to see that they got reasonably fair play and that the proper materials were sent them in the proper order. Another important thing is the getting of suitable workmen when a job is sufficiently far advanced to enable you to proceed with the work. Men who are accustomed to light inside structural work cannot be entrusted with shell plating, for example.

SECRETARY CAPPS: I am going to speak a word for Mr. Dickie now. I am one of the unfortunates who was a superintending constructor at the Union Iron Works, but never heard of any troubles that took place in the years of my administration there. Mr. Dickie, as you may not all know, is one of the most charming personalities that I have ever met, and a very profound humorist. But leaving the humorous side of the question, there should be no real difference between the constructor and the manager or president of any establishment. Their interests are absolutely the same, for they are trying to accomplish good results, each in his own proper way. I think the experience of most people is that their relations are harmonious. As far as the firm represented by the author of the paper is concerned, I think they have a great deal of glory in the vessels that they have turned out, and if their trouble has been quite as serious as might appear from a cursory reading of the paper, the magnificent record made by the *Oregon* and the *Alabama* would not be known.

President Griscom here assumed the chair and in the absence of the author the following paper was read by Lieutenant Commander White:

THE TACTICS OF THE GUN.

BY LIEUT.-COMMANDER ALBERT P. NIBLACK, U. S. N., ASSOCIATE.

Abstract.

The author's argument is that the battleship is the epitome of sea power and all calculations for defence must be based on the battleship as a unit. While protection from other classes of vessels, such as torpedo boats, should be considered, the battleship is primarily meant to fight battleships on the high seas, and it is this view of gun against gun that is dealt with in the paper. The author believes that it is only by luck or by indirection that a model battleship can sink another by gunfire alone, and in the future ships will probably not be set on fire as at Santiago and Manila.

The object of tactical manœuvers of a fleet previous to or in a fleet engagement should be: First, to get the enemy within a close effective range; second, to get a superior position in order to mask some of his fire or increase the effect of your own; third, to hold an advantage gained, or, losing it, to manœuver for a fresh one; fourth, to avoid waste of ammunition; fifth, to get out of a position of disadvantage or one in which a move of the enemy may threaten to place you; sixth, to concentrate gunfire on certain ships of the enemy, in order to reduce the tactical efficiency of all his ships by crippling one or more; seventh, but of all things to deliver a rapid, crushing fire at the earliest possible moment, thereby injuring at once his initiative and increasing your own offensive power in a geometrical ratio as you destroy his.

A comparison is made between the tactics of the sailing ship period and that of the modern steam fleet. In the days of the former, as all guns were necessarily mounted on broadside, the bow and stern fire was in-

considerable, the only formation was in column, and the preliminary manœuvering was generally to secure the windward position. In an army on shore, on the other hand, the line must necessarily be the offensive formation, but with modern battleships the installation of pairs of heavy guns in the ends of the ship and the introduction of the ram and torpedo have changed naval tactics to a sort of compromise of sailing ships and military tactics. The function of the gun is to destroy the battery and *personnel,* as armor and the water-tight subdivisions make it well-nigh impossible to reach the vitals of the ship with gunfire alone, except with plunging fire at long distances, and destruction is the function of the ram and torpedo. The author makes a strong plea for retaining the submerged torpedo, which has been omitted in the most recent design for battleships. In a very interesting series of diagrams, he illustrates the area of maximum concentrated gunfire of a fleet in different formations. Since the Santiago battle the navies of the world have been paying close attention to gun practice, and the rapidity of discharge and number of hits of the guns of the English fleet show a wonderful marksmanship, and it is these two points which will tell in engagements. Efficiency in gun practice in our navy is lowered because of the continual change in the *personnel* of our ships and the small appropriation for gunnery exercises, which amounted to but $12,000 for the current year. In closing an appeal is made for the navy's consideration by Congress, and especially for an increase in the appropriation for target practice.

DISCUSSION.

ADMIRAL BOWLES: I think the Society is much indebted to Lieutenant Niblack for bringing to our attention the essential purposes for which these great ships are built. The only criticism that he makes upon what is being done is that of the omission of the submerged torpedo boat, and he is at a loss to understand why the Board of Construction came to that conclusion. I really do not feel called upon to defend the Board of Construction, and I will simply state my position in the matter. When the members of the board conclude that a submerged torpedo tube is not a desirable thing, you may readily imagine that I, as a constructor, am very pleased to leave it off.

LIEUTENANT WHITE: I will say that the paper will perhaps explain in a way the reason for our desiring ships of such great size. If you could take a whole fleet and compress it into one vessel—that is, the aggressive power of a whole fleet and compress it into one single vessel—you would realize what I mean. The leading ship of the line in an attack will bear the brunt of the attack. The defensive properties of that ship must be great enough to meet that attack, and her offensive properties must be as great as possible in order to defeat it. The concentration of fire, to which the author of the paper calls attention, will be directed always upon the nearest vessel, of course. The leading ship of the line, which will be the admiral's ship, will be subject to the greatest attack necessarily, because our modern battles will be more or less a battle of follow your leader. The idea of being able to signal during battle is, I think, an exploded one—at least from our experience in the matter. I would like to call attention to the matter of our ordnance expenditures. It will be necessary, in order to bring the offensive powers of our vessels up to the very highest point, to armor them completely with the latest modern guns and modern gun mounts. To that end almost all the broadside guns now on our ships will have to be remodeled. I think the author places entirely too much reliance upon the use of the ram. I do not believe the ram will ever be used, as it is entirely too dangerous for the vessel that has the ram. In fact, probably both vessels will go down. Then, in regard to the defeat of a ship, he seems to think that if the personnel on deck is commanding the batteries the ship would still be a dangerous weapon. Now, it is the experience in the past of the naval battles, that, after a certain percentage of the personnel has been put out of action, that practically destroys the unit in which it is contained.

SUBMARINE TORPEDO BOATS—PAST, PRESENT, AND FUTURE.

BY LAWRENCE SPEAR, MEMBER.

Abstract.

This paper presents first a brief and well-condensed abstract of the history of the submarine boat from the first of the last century to the present time. The three leading nations in the construction of the modern submarine are stated to be France with a total of 44 built, building, and provided for; Great Britain with 10, and the United States with 7. The vessels composing these various fleets are taken up in further detail and discussed with reference to their historical development and their technical features. Reference is made in particular to the type accepted for the United States naval service, the Holland, and the leading features and possibilities of the system are presented in detail. Regarding the future the author gives his reasons for believing in the further development of submarine boats under four types and two main groups, to conform to the different conditions in the different maritime countries. These are as follows: Group 1 would be suitable for many of the European countries, and would include the large *offensive submersible,* self-supporting, with auxiliary bottom working features, and the small *defensive submarine* for torpedo work only. Group 2, suitable for the United States and similarly-situated countries, would include the small *offensive* ground working *submarine* or *submersible* (with auxiliary armament) and the medium-sized *defensive submersible* for torpedo work only.

The paper is illustrated with a number of plates relating to the historical development, and to the modern boats of the Holland type.

DISCUSSION.

MR. LEWIS NIXON: One great drawback to submarine navigation in a practical way was the fact that we could not depend upon a hydrocarbon engine until a few years ago. When the department outlined most of the qualities which fixed the design of the *Plongeur,* Mr. Holland, with whom I used to discuss the subject a great deal, was very anxious to have some submarine boat built, but I pointed out to him at the time that it would only result in disaster, as it was impossible to put three engines and a boiler in a place where men would want to live, and I refused to be connected with

the building of such a boat. He came to me, however, when the boat was well along, and we found we could get a hydrocarbon engine which was satisfactory, and in that we started the original Holland boat which has been the forerunner of the present boat. So far as speed is concerned, I am not one of those who believe that excessive speed is necessary in these boats. I think the submarine boat is made for defence, and that it must necessarily move slowly. Eight knots, however, on top of the water, and seven knots under the water is a very fast speed, as fast probably as some of our ships of twenty years ago, and it is all that seems to be necessary in the present condition of submarine warfare. Of course, if we could better the engine we could put more power in the boat, but whether in doing that we would not sacrifice some of the manœuvering qualities of the submarine boat is a question that leads to doubt in my mind. I think the submarine boat as built originally by Nordenfeld was, as Mr. Spear points out, a very mistaken conception. The submarine boat, to be used for defensive purposes, must be used after sounding and must be short enough to get at the bottom of a ship in comparatively shallow water; in other words, to be in a position to nibble at the boat and fire a torpedo at her. This would be impossible in a very long boat. I think the French have sacrificed a great deal of the manœuvering power in order to obtain the other qualities of the boats of this class. I do not believe in what Mr. Spear calls the submersive boat. A Jack-of-all-trades, even in ships, is a poor article. In other words, to be a perfect submarine boat, I think we would have to sacrifice too much if we wanted to make that boat capable of fighting on the surface. When Mr. Whitney was Secretary of the Navy we had a board which proposed a heavy armored submarine boat, a submerged boat, laying itself a little deeper in the water when in action, but which was supposed to be able to get up to a great battleship and stand the attack of her guns, if necessary. That may possibly be a development of the future. We have in the hydrocarbon engine possibly a great surface speed, and I think probably it will be necessary to keep some form of motor of this kind on a boat, as the boat would then be self-contained.

MR. MONTEAGLE: I think the gasoline engine is in many respects the best, but it also suffers from drawbacks, such as danger of explosion and the fact that it cannot be reversed, started, and adjusted without the use of external means. This means complication, of course, and these drawbacks are likely to be aggravated when you come to the higher power. I think it is very likely that we shall want greater power, because when all other resources are exhausted for the improvement of a type of boat there is always one resource left to the naval architect, and that is an increase in displacement. The steam engine has not in this country been given a fair trial in these boats, because the case of the *Plongeur* I do not consider a good example. There 1,500 horse power was cramped in a very small boat, and the result could hardly have been different than it was. The steam power is used in France in conjunction with electricity in these boats, and with a fair measure of success. These boats are not greater than 200 tons, and there are examples of these boats having made voyages from Cherbourg to Havre and back again within 21 hours—a distance of 142 miles. It is said that the crew suffered exceedingly from the excessive heat, but they managed to stand it, and the boat did the work, and they were under water for two hours continuously when they discharged torpedoes. This shows that the steam engines can be used in a similar boat. The French are not quite satisfied with this type, and they are now trying an additional motor. They do not seem to have entire faith in the installation, for they have provided that in case they do not work satisfactorily they are to be exchanged. The construction of all these boats has been suspended by the French Minister of Marine because he wants to see tests of the different types before he settles on what he thinks will be the best type. For purely submarine work we have at present probably nothing better than electric power. In France the Minister of Marine has invited a famous chemist to design the machinery for the new boat where liquid air is to be used.

ADMIRAL BOWLES: I want to make a few slight criticisms on this paper. I am in the dark as to what is meant by submersive and what is meant by submarine, and what is an offensive submersive and a defensive submarine boat. I am appalled at the fact that there are two groups now of submarine boats, with four sub-divisions. I do not think it is fair to spring so many things upon us all at once. There is no doubt that the submarine boat as it exists to-day is in a measure a success, particularly in those built for the United States Government. There is no doubt also that the boat has some value as it is now. It has an undoubted moral value. The offensive military value of a submarine boat with a speed of eight knots on the surface, and making as much fuss as a battleship, however, I should think, is seriously open to question.

A MEMBER: There is one use of submarine boat that I think ought to be mentioned, and that is a battleship carrying a submarine boat as part of her equipment. A submarine boat can be built perfectly workable, having a displacement of 15 or 20 tons, and 30 to 40 feet long, which could be carried on board a battleship, like the other boats. When that vessel is in a foreign port, she could use that submarine boat for reconnoitering in and out of the harbor. I might at the same time say that I do not think it is at all necessary to have high-speed submarine boats. I had the misfortune to construct one in England in 1886. As soon as I went below the surface I could not see at all. Another trouble was the compasses; as soon as I was submerged my compass was not reliable within two or three points. Of course that could be got over by artificial means, and not using a compass at all.

MR. F. G. HALL: I want to say in reference to the gasoline engine that it seems rather odd that they should have stuck entirely to the gasoline engine when, in the last four or five years, there have been engines used for commercial purposes, and on launches and on various surface boats, up to 30 horse power, and they could be used just as well on submarine boats. No large engines have ever been built to burn kerosene oil for submarine boats, but I am familiar with the workings of some of these engines, and it has been stated by one manufacturer that I know of that such an engine could be built, of 160 horse power, which

could be used on a submarine boat. It would seem that that class of engines should have a hearing before the gasoline engine, owing to its great safety.

Mr. Spear: I will be very brief in answering the remarks that have been made. In regard to compasses getting out of order when the boat was submerged, I will say that the fact that his compasses did not work proves nothing. We have had compasses that do work. It depends upon the compass, and upon knowing your compass. Passing now to what Mr. Nixon said, I want to accord my hearty agreement with him in the folly of attempting to force the man that is building submarine boats to build one to run as fast as a battleship. I gave my opinion as to what I thought the future might develop. I agree with Mr. Nixon about the necessity of going slow and not sacrificing manœuvering qualities. Mr. Monteagle has pointed out one of the difficulties in connection with the explosive engines. Considering the fact that one of our boats ran 12 hours at full power, which no surface torpedo boat can do, and which no naval vessel can do without difficulty, I think that is a good example. So far as the ability to work those engines at the speed which they have to work is concerned, that is now a matter of record.

Owing to the lateness of the hour the President stated that the two remaining papers would be read by title only.

MEASUREMENT RULES FOR YACHTS, WITH SPECIAL REFERENCE TO RACING CONDITIONS.

by F. W. Belknap, naval architect.

Abstract.

This paper gives an historical sketch of the rules for measuring yachts extant in England and this country, and shows how the change in the rules brought out different types of vessels. In each type one or more features, such as load-water-line length, length over all, depth, beam, etc., have been accentuated at the sacrifice of others, so that the resulting types have been more or less of freak design. In recent letters sent out by the New York Yacht Club to many yacht designers on this side and abroad, it was the opinion that displacement should be the ruling element in determining the rating. Most of our designers believe that the present rules should not be continued and that a craft capable of going to sea should be the adopted type. The English designers believe that their present rule is satisfactory. It is as follows: Length + beam + .75 girth + 4 times the difference between chain and skin girth + .5$\sqrt{}$ sail, the whole divided by 2.1. An American rating, while taxing the dimensions, should leave the design of the model entirely to the naval architect and should in no way handicap the model.

PRIZE COMPETITION PAPER.

Balancing of Valve Gears.

by L. D. Lovekin.

Abstract.

This paper is divided into two main parts, the first dealing with the theory of the inertia forces developed by the moving parts of the valve gear, and the second with the description of a form of balance cylinder intended to carry as perfectly as possible the combination of weight and inertia forces which are due to the combined action of gravity and the inertia of the moving masses. The author shows that by a suitable arrangement of ports in the balance cylinder a steam diagram may be obtained which, representing the history of the action of the steam on suitably proportioned pistons, will result in very closely balancing off the gravity and inertia forces above referred to, and will thus leave little beyond the resistance due to friction to be overcome by the valve rod and eccentric gear itself.

Votes of thanks to the American Society of Mechanical Engineers for the use of its assembly room during the convention, and to President Griscom, were then proposed and passed and the meeting was adjourned.

Saturday was devoted to inspecting the plant of the New York Shipbuilding Company, Camden, N. J., at the invitation of Mr. Henry G. Morse, president of the company. A special train took about two hundred and fifty of the members of the Society to Camden, arriving at about half past 11. As the members arrived they took position in front of the administration building of the shipbuilding company and were photographed by Mr. Enrique Muller, of Brooklyn, N. Y. A substantial lunch was then served in the dining rooms in the basement of the administration building, and following this the members had free run of the shipyard. The entire mechanical equipment of the plant was inspected with much care, as well as the several ships under construction on the launching ways. The special features of this shipyard were fully explained in Marine Engineering of December, 1901, in a very complete article describing this plant. The special train left Camden at about half-past 3 on its return to New York. The weather was propitious, and altogether the trip was evidently very much enjoyed by all the members.

Oil Fuel on the Kensington.—The steamship *Kensington,* of the International Navigation Company, has made a round trip from England with one of her single-end boilers equipped with oil-burning appliances of the Flannery-Boyd system. If the owners find the system successful, all the boilers of this ship and others may be equipped with it.

Turbine Steam Yacht.—On October 21 there was launched by Stephen and Sons, Linthouse, the first yacht to be fitted with turbine engines. She was christened the *Emerald* and was built to the order of Sir Christopher Furness. Her dimensions are: 236 feet in length, 28 feet 8 inches breadth, and 18 feet 6 inches depth. The intention of the designer is to obtain a speed of about 16 knots with entire absence of vibration and an exceptionally light coal consumption. The vessel has three sets of steam turbines, three shafts, and five manganese bronze propellers—one propeller on the center shaft and two each on the side shafts. All the turbines are supplied by the Parsons Marine Steam Turbine Company. The main boiler is of large diameter and is fitted with forced draft.

New Three-Masted Schooner Madeleine.

The three-masted schooner *Madeleine,* which was launched September 2, 1902, from F. S. Bowker's yard, at Phippsburg, Me., is a model for this class of vessel. She was designed by F. S. Bowker especially for the lumber trade, and great pains were taken in construction to make her an ideal schooner of this type.

The principal dimensions are as follows: Length over all, 147 feet; beam, molded, 34 feet; depth, 12 feet. The keel, which is 140 feet long, is composed of two 13-inch square timbers and a shoe 3 inches thick, making a total of 29 inches of solid rock maple and birch. These are bolted together by 1 1-4-inch wrought-iron bolts. The frames below the load-water line are yellow birch and rock maple, and, above, white oak. All frames 12 inches square, spaced 30 inches center to center. The main deck beams are 11 inches by 13 inches hard pine on every frame, except the hatch beams, which are 11 inches by 14 inches. Each beam is connected to ceiling by 9-inch hanging knees and 10-inch knees on hatch beams. These knees are bolted to the ceiling by 1-inch wrought-iron bolts.

The main deck plank is 3 1-2 by 4-inch white pine in 30-feet lengths; each seam is calked with five threads of the best oakum. The floor ceiling, which is 4 by 12-inch hard pine, is spiked and treenailed, and the ceiling from floor to hanging knee strake is 8 by 14-inch hard pine bolted with 1-inch wrought-iron bolts 2 1-2 feet apart, and scarfed with 7-8-inch iron. The hanging knee strakes are 9 inches by 14 inches, bolted with 1-inch wrought-iron bolts. The outside planking is hard pine of varying thicknesses. The garboard strakes are 6 by 14 inches, edge bolted to keel; the rest of planking on bottom is 4 inches thick and 14 inches wide, 12 inches on bilge, and 7 to 10 inches to deck.

The quarter deck is raised 4 feet above main deck and runs 8 feet forward of after house in order to take main sheet traveler. The main deck rail is a continuation of the quarter deck and is made of 6 by 14-inch hard pine with 7 feet locked scarf.

The quarters in the after cabin are finished in white wood and cypress. The commander's room is large and commodious, situated on the starboard side of the after house. Opening off the after side is the bathroom. The after cabin occupies the main part of the after house. It is furnished with quartered-oak furniture, handsomely upholstered. On the port side, leading from the after cabin, is a large guests' room, finished in white wood and cypress. The dining saloon is just forward of the after cabin. On the starboard side leading from the dining saloon is the steward's state room, while opposite is a large pantry. The second officer's state room is on the port side just forward of the pantry, leading also into the dining saloon. The forecastle, galley, and engine room occupy the forward house.

THREE-MASTED SCHOONER MADELEINE, BUILT AT PHIPPSBURG, ME.

The *Madeleine* has accommodations for four seamen, besides the master, one mate, steward, and engineer.

The engine room is very completely fitted out, contains a 42-inch vertical boiler, a Hyde windlass steam winch, and a wrecking pump. The sails are handled by leads to the catheads of the winch, which project outside of the engine room. The schooner is equipped with four stockless anchors weighing 2,300, 2,100, 600, and 300 pounds respectively. The rig is the same as usually

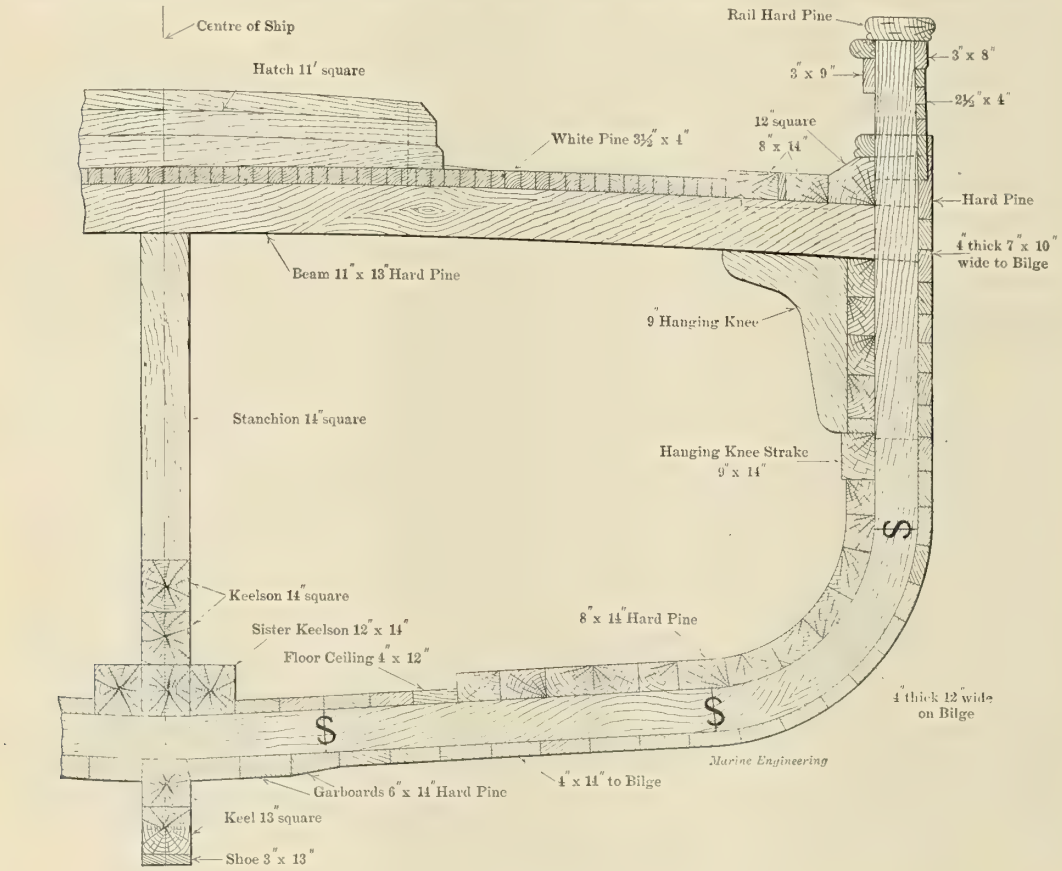
found on three-masted schooners. The total number of yards of canvas in the sails is 3,500, and all of the sails, excepting the topsails, flying jib, and outer jib (which measure 800 yards and are of No. 5 duck), are made of No. 0 duck 22 inches wide.

Old Prison Ship Jersey.—In building a section of the new ways for the construction of the battleship *Connecticut* at the Brooklyn Navy Yard, the famous English prison ship *Jersey* was discovered. At the close of the Revolution the hull of the vessel was burned, and now lies in about two fathoms of mud and water. The *Jersey* was one of six British prison ships, and the stories of hardship of the prisoners on board are most appalling. About 1,200 were confined on her constantly, and, it is estimated, 11,000 of her prisoners are buried along the Brooklyn shore. In her day she was a first-class line-of-battleship and had a crew of 400 men.

Increased Lake Fleets.—It is reported that the United States Steel Corporation proposes to build a large addition to its fleet of ore ships. Realizing the fact that the berths of the American Shipbuilding Company are all filled and were liable to be kept so, the Steel Corporation, acting through the Pittsburg Steamship Company, has secured an option on all berths to be vacated during the year 1903 at Buffalo, Cleveland, Detroit, Lorain, Chicago, and Superior. It is probable that the proposed steamers will be about 550 feet long and on the present draft have a carrying capacity of 9,000 gross tons each.

OIL-FUEL INSTALLATION ON STEAMSHIP J. M. GUFFEY.

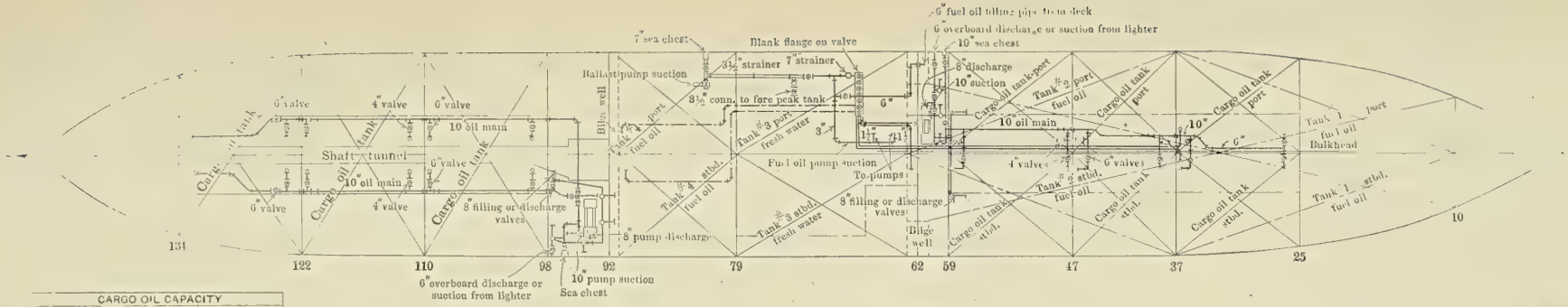
Among the most recent ships fitted for burning oil fuel is the steamship *J. M. Guffey*, of the J. M. Guffey Petroleum Company. This steamer was the first vessel built by the New York Shipbuilding Company, Camden, N. J., for the firm of Robert Dollar and Company, of San Francisco. Just prior to her completion she was bought by the J. M. Guffey Company, and arrangements were made for transforming her into a tank ship for carrying oil in bulk, and in addition to carrying oil as cargo she was fitted for burning oil as fuel.


Centre of Ship
Hatch 11′ square
Rail Hard Pine
3″ x 8″
3″ x 9″
2½″ x 4″
12″ square
8″ x 14″
White Pine 3½″ x 4″
Hard Pine
4″ thick 7″ x 10″ wide to Bilge
Beam 11″ x 13″ Hard Pine
9″ Hanging Knee
Stanchion 14″ square
Hanging Knee Strake 9″ x 14″
Keelson 14″ square
Sister Keelson 12″ x 14″
Floor Ceiling 4″ x 12″
8″ x 14″ Hard Pine
4″ thick 12″ wide on Bilge
Marine Engineering
4″ x 14″ to Bilge
Garboards 6″ x 14″ Hard Pine
Keel 13″ square
Shoe 3″ x 13″

MIDSHIP SECTION OF THREE-MASTED SCHOONER.

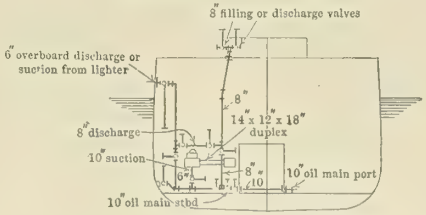
The ship as first constructed, and its machinery, were fully described in the August number of MARINE ENGINEERING, 1901, and it is the object of this article to give a brief description of the ship in its present condition and the method employed for burning oil as fuel, which has demonstrated itself to be perfectly satisfactory after several months' service between the ports of New York and Port Arthur, Texas. For the sake of comparison a few of the principal items of the machinery will also be mentioned.

As shown by the accompanying plans, the steamer is 300 feet in length between perpendiculars, 40 feet beam, 21 feet loaded draft, and has a load displacement of 5,675 tons when carrying 945,500 gallons of oil. She is fitted with six tanks, as shown on plans, three forward and three aft, the forward tanks being arranged with a centerline bulkhead extending from the forward cargo

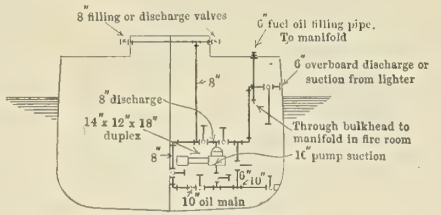


CARGO OIL CAPACITY				
		Cu. ft.	Gal.	Tons.
Tank No. 1		21480	160670	549.3
" " 2	Excluding	18564	138858	474.7
" " 3		22144	165640	566.3
" " 4	Trunks	21446	160416	548.4
" " 5		20527	153540	525.0
" " 6		10160	120877	413.3
	Total	120321	900000	3077.0

FUEL OIL CAPACITY			
	Cu. ft.	Gal.	Tons.
Double bottom #1	4557	34086	116.5
" " #2	5661	42341	144.8
" " #4	3018	22572	77.2
Total	13236	99000	338.5


8" filling or discharge valves
6" overboard discharge or suction from lighter
8" discharge
14" x 12" x 18" duplex
10" suction
8" oil
10" oil main port
10" oil main stbd

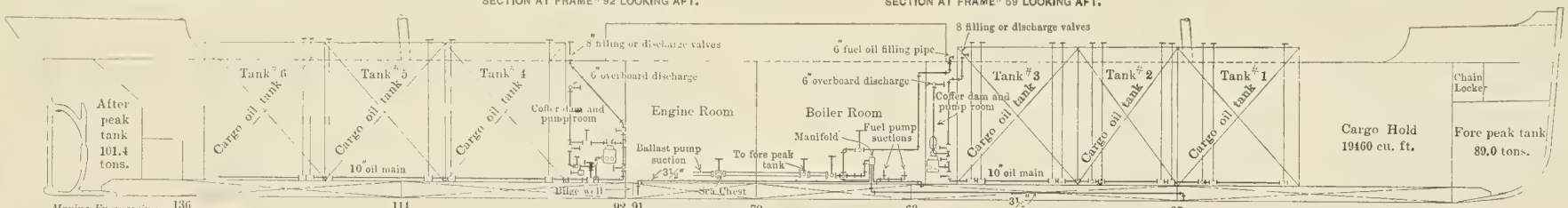
SECTION AT FRAME #92 LOOKING AFT.


8" filling or discharge valves
6" fuel oil filling pipe, To manifold
6" overboard discharge or suction from lighter
8" discharge
14" x 12" x 18" duplex
Through bulkhead to manifold in fire room
10" pump suction
10" oil main

SECTION AT FRAME #59 LOOKING AFT.

WATER BALLAST	
	Tons.
Fore peak	89.0
Double bottom #5	134.8
" " #6	60.5
" " #3 (fresh)	107.6
After peak	101.4
Total	493.3

HOLD CAPACITY	
Hold	19460 cu. ft.



Tank #6, ballast. Capacity for both stbd. and port tanks = 60.5 tons

Tank #5, ballast. Capacity for both stbd. and port tanks = 134.8 tons

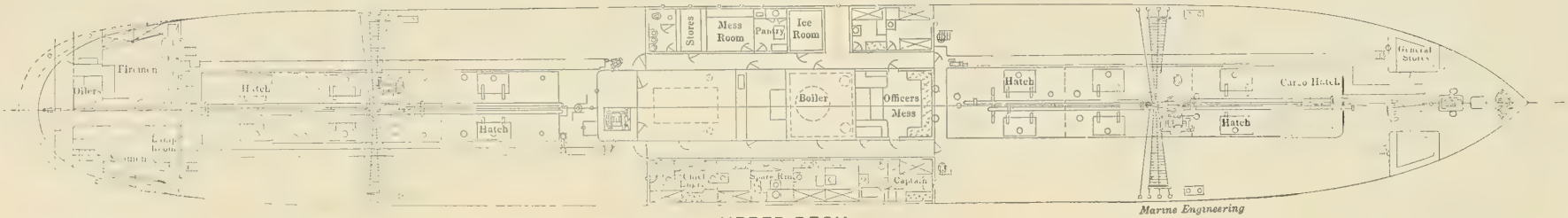
Tank #4, fuel oil.

Tank #3, fresh water. Capacity for both stbd. and port tanks = 107.6 tons

Tank #2, fuel oil.

Tank #1, fuel oil.

Cargo oil pipes indicated by ———
Fuel " " " " ———

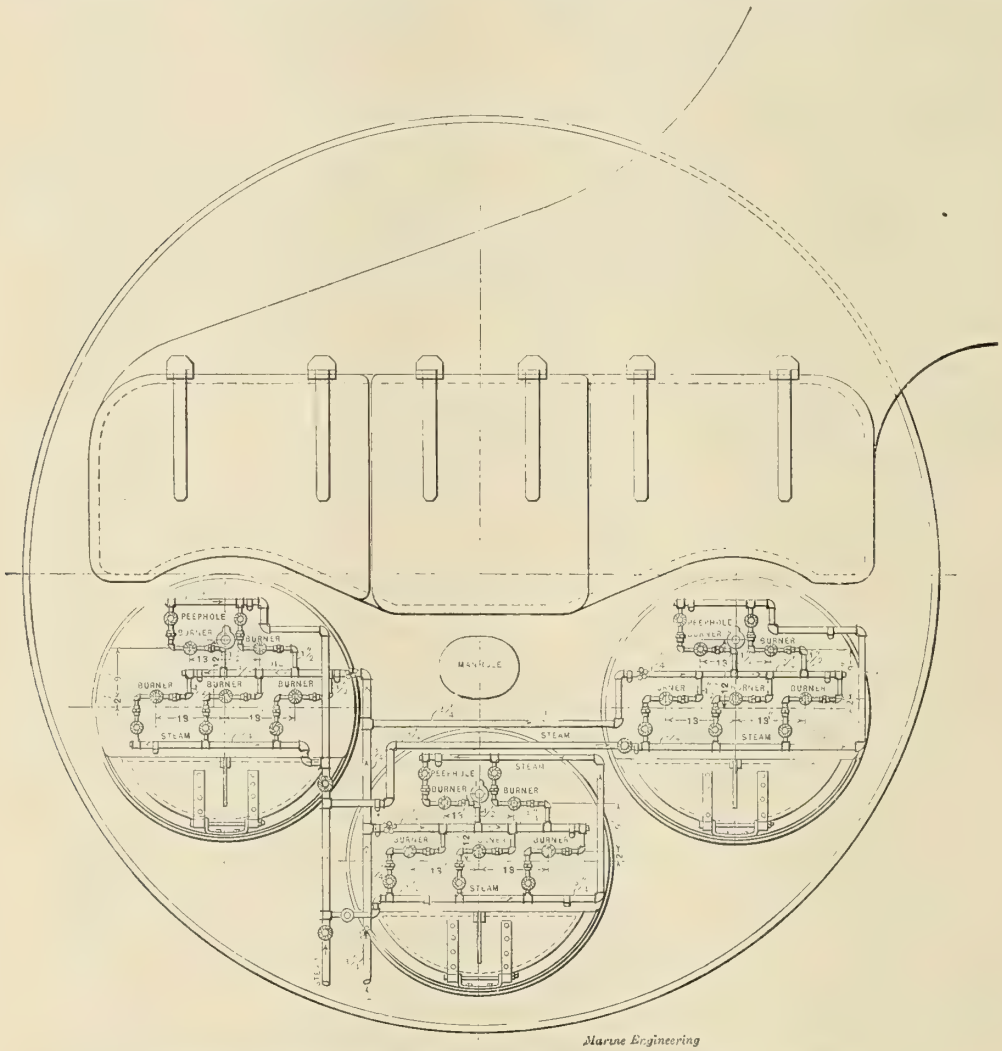


UPPER DECK

DECK PLANS AND SECTIONS SHOWING ARRANGEMENT OF CARGO, OIL TANKS, AND FUEL OIL SYSTEM ON THE TANK STEAMER J. M. GUFFEY, BUILT BY THE NEW YORK SHIPBUILDING COMPANY, CAMDEN, N. J.

hold to the boiler-room bulkhead, while the after tanks run clear across the ship and are divided in the fore-and-aft direction by the shaft tunnel running through them.

The main engines are of the vertical triple-expansion type, with cylinders 22, 36, and 59 inches in diameter, all having a common stroke of 42 inches and driving a single screw of 13 feet in diameter by 16 feet pitch. There are two main boilers, each 14 feet diameter by 12 feet 2 inches long, with three furnaces 46 inches



Marine Engineering

ARRANGEMENT OF OIL AND STEAM PIPING ON THE BOILERS OF THE J. M. GUFFEY.

diameter. The total heating surface is 4,212 square feet.

The auxiliary machinery consists of—

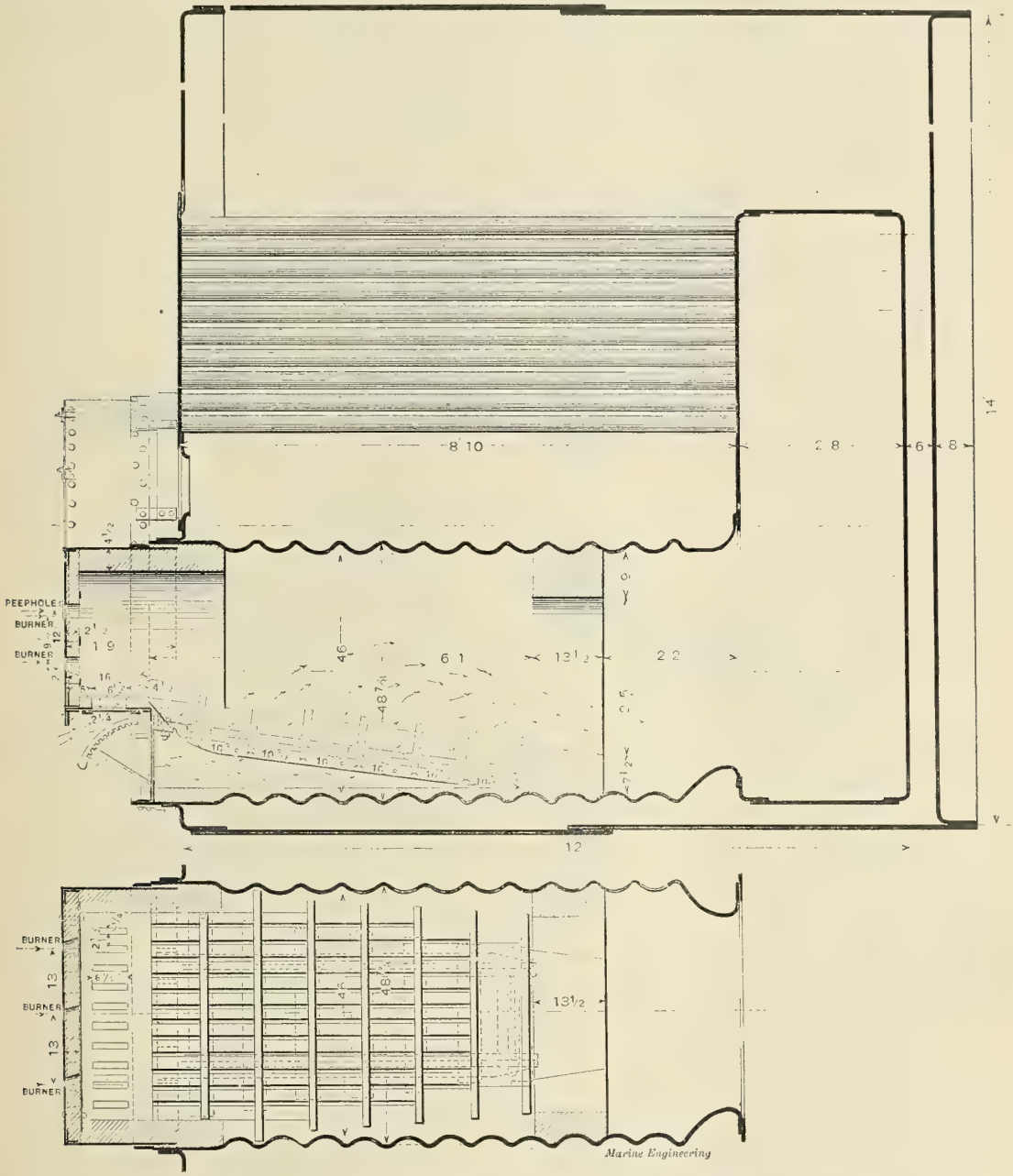
One main feed pump, 8 by 5 by 12 inches, duplex,
One auxiliary feed and fire pump of the same type and size,
One ballast pump in engine room, 12 by 14 by 12 inches, duplex,
One water service and sanitary pump, 7 by 4 1-2 by 10 inches,
One circulating pump, centrifugal type, 10 inches, with 9 by 9-inch engine,
One 7 by 7-inch steering engine,
One 10-K.W. dynamo, with 6 by 6-inch engine,
One 12 by 12-inch towing engine, and
Two cargo-oil pumps, 14 by 12 by 18 inches, duplex.

The original arrangement of the ship made it necessary to provide two independent pumping systems for handling the oil cargo in the forward and after tanks of the ship, and by utilizing the space of the cofferdams two pump rooms, one just forward of the fire room and another just aft of the engine room, were installed. Each pump room is fitted with a powerful horizontal duplex Blake pump, as above specified, having a 10-inch suction and 8-inch discharge, capable of discharging the ship's load in less than ten hours.

The arrangement of the piping enables the pumps not only to discharge the cargo, but also to load the ship by drawing the oil either from lighters alongside or from tanks ashore and discharging it into any of the ship's tanks through the oil main. Should it ever become desirable to transfer the oil from one tank into another this also may be done by proper manipulation. This same pumping system is used for ballasting the cargo tanks from the sea for the return trip, when no oil or other cargo is carried, as the original ballast tanks in the inner bottom are used for carrying fuel oil for the

boilers. The total capacity of fuel-oil tanks is about 332 tons and is ample to run the vessel for a round trip between New York and Port Arthur, Texas.

There are two pumps for delivering the oil from the bunkers to the burners, only one of which is operated at a time, the other being held in reserve. One of these pumps is shown in the cut on page 636. The vertical pipe in the middle front connects the pump with the oil bunkers. The delivery of the oil is, first, into the cylindrical heating chamber forming a part of the pump foundation. From the heating chamber it is conveyed directly to the burners through the pipe shown on the lower right side. The exhaust steam from the pump enters the heating chamber at the upper left side and passes out directly below. In this manner the oil is heated to a temperature somewhat less than the temperature of the exhaust steam. The pump pressure put upon the oil in the heating chamber is about 50 pounds and is automatically regulated by a pop valve located on the opposite side of the pump, which returns the surplus discharge to the pump suction.

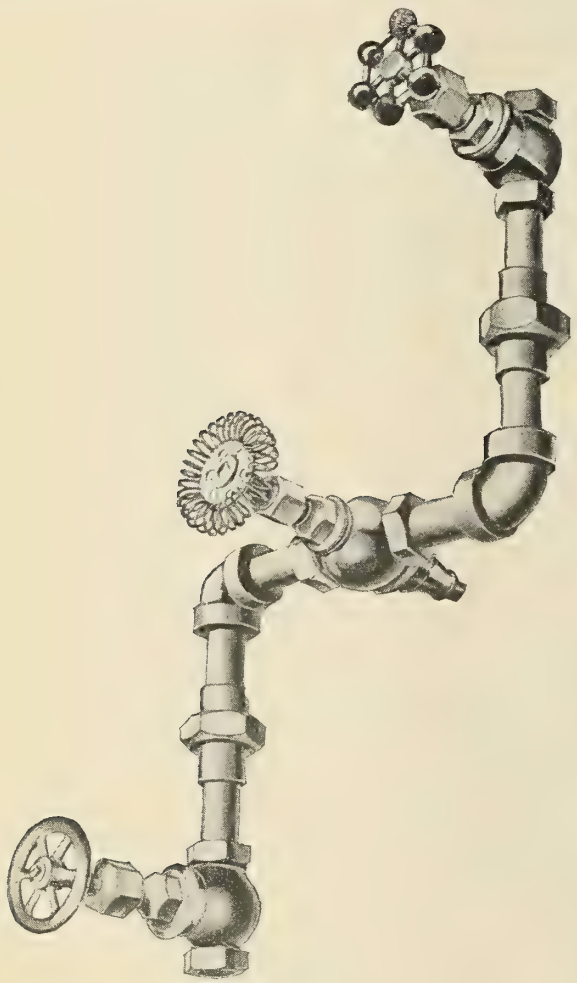


SECTION OF BOILER AND PLAN OF FURNACE ON THE J. M. GUFFEY, SHOWING THE ROCKWELL SYSTEM OF OIL BURNING.

On pages 634, 636 are shown the burners and pipe connections on the front of one of the two boilers. There are five burners in each of the three furnaces. The atomization of the oil through the burners is by steam at 80 pounds pressure. The diameter of the steam nozzle is 1-4 inch. The diameter of the oil nozzle is 3-32 inch and it is situated centrally in the

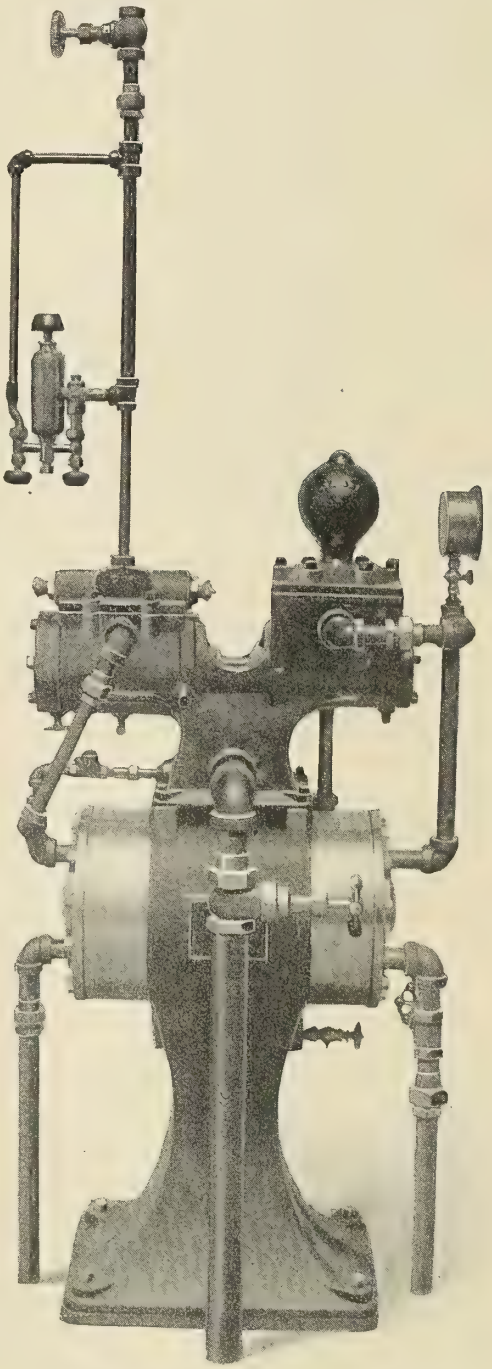
steam nozzle, forming an annular steam opening about 1-16 inch wide. In this manner perfect atomization is effected with the smallest expenditure of steam, and combustion begins within the extension hoods, not at the rear of the furnaces. Natural draft supplies the air for combustion. The air in passing through the highly-heated brick-lined hoods, or through the inclined brickwork forming the bottoms of the furnace chambers, is divided and heated before coming in contact with the thoroughly vaporized oil, and rapid and clean combustion is the result.

The absence of compressed-air and fan blowers leaves the equipment exceedingly simple, saves room, and saves cost.



THE ROCKWELL OIL BURNER INSTALLED ON THE J. M. GUFFEY.

The boiler section herewith, page 635, shows clearly the firebrick construction of the furnaces. In order to secure complete combustion of the oil vapors as discharged from the burners, it is absolutely necessary that the temperature of the furnace be maintained at a high degree near the front, where the oil enters; therefore the brick-lined chambers or hoods at the front of each furnace. Part of the air to support combustion is drawn in through the adjustable openings at the bottom of these hoods, and part through the inclined brick bottoms, the latter acting in the capacity of a bed of coals to heat the air as it passes through. A Scotch marine boiler of average length is a short boiler in which to burn oil. Its furnace and combustion chambers, unaided by firebrick, are poor supporters of combustion of oil vapors, however good heating surfaces they may be for coal fuel. The oil engineer must choose between heating surface and radiating surface. The inclined bottom in this setting insures an entrance of air throughout its length, so that the air is divided and heated, while it increases the heating surface over that of the ordinary coal-grate setting and causes a higher temperature in the rear bottom. The arch sprung over



OIL PUMP AND HEATER ON THE J. M. GUFFEY.

the bridge wall serves both to intensify the combustion and to retard the gases, so that there is no impinging effect upon the back plates and staybolts. The *Guffey* has now been burning oil about five months, and her staybolts and flue beads show no signs of injury. Her flues are always clean, and smoke seldom, if ever, shows at her stack.

The furnace fronts can be easily removed for inspecting the boiler whenever necessary, all parts are easily accessible, the position of the firebrick work makes it durable, and the furnace castings cannot burn out.

The prevailing idea in this system is to thoroughly atomize the oil and to intermix it with the heated air of the furnace, which is the only successful method for complete combustion. The proof of the fact is the clean plates, flues, and brickwork in the *Guffey's* boilers after five months' firing.

For starting the fires in the main boilers an upright 15-horse-power donkey boiler of the Lidgerwood type is installed, and this boiler furnishes steam for the pumps and the burners until sufficient steam is raised in the main boilers to supply the system.

No exact data are available at present, but on one run of 119 hours the boilers consumed 34,000 gallons of oil, running at about 1,650 I.H.P. This, as will be seen, gives a result of about 1.32 pounds of oil per I.H.P. per hour, *including all auxiliary machinery.* The oil weighs 7.65 pounds per gallon.

Steamship Korea.—The new steamship *Korea,* belonging to the Pacific Mail Steamship Company, on her first homeward voyage from Yokohama to San Francisco lowered the best record heretofore existing by two days, making the trip in ten days and fifteen hours.

Cup Syndicate.—The New York Yacht Club has accepted the challenge of Sir Thomas Lipton for the America's Cup, and it is announced that the new cup defender will be owned by a syndicate composed of the following men: Elbert H. Gary, Clement A. Griscom, James J. Hill, William B. Leeds, Norman B. Ream, William Rockefeller, Cornelius Vanderbilt, Henry Walters, and P. A. B. Widener.

In Honor of John Fritz.—A most memorable meeting of four hundred distinguished men interested directly and indirectly in the steel and iron industry took place at the Waldorf-Astoria on November 1 to do honor to John Fritz, the oldest steel master in the country. The John Fritz gold medal for achievement in the industrial sciences was founded, to be awarded only by a committee of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of London Engineers, and the American Institute of Electrical Engineers. The medal was designed by the American sculptor, Victor B. Brenner, and bears the head of John Fritz. Mr. Fritz was given the first medal on this occasion, which was his eightieth birthday. He is a native of Pennsylvania, and after a common-school education he began life as a blacksmith, and has since been connected with almost every important step in the iron and steel industries, his principal work being the care of the forge and armor-plate plant of the Bethlehem Steel Company.

Steamer Queen Caroline.

The Queen Anne Ferry and Equipment Company's new passenger steamer *Queen Caroline* was designed and built by the Baltimore Shipbuilding and Dry-dock Company, Baltimore, Md., for service between Cape May, N. J., and Lewes, Del. The contract for the construction of the new steamer was signed November 1, 1901, and stipulated a speed of 16 miles per hour and delivery not later than July 1, 1902. Work was begun on the new boat without delay, and the first section of keel was laid on December 9. She was launched May 13, 1902, and had her first dock trial June 27. Two days later all the finishing touches were completed, and on the morning of July 1 she left the works for a trial trip to Love Point, on the Chesapeake Bay. This trial showed that the boat fulfilled all the requirements.

The new vessel is a fine specimen of a modern excursion steamer of the single-screw type. Her hull is of open-hearth steel and has the following dimensions:

Length between perpendiculars	187 ft. 0 in.
Length over all	200 ft. 0 in.
Beam, molded	31 ft. 0 in.
Depth at lowest point of sheer	13 ft. 3 in.
Mean load draft	7 ft. 9 in.
Corresponding displacement	640 tons.

There are three decks and five transverse bulkheads; four of the bulkheads are water-tight. The main saloon is on the promenade deck and has a dome skylight extending the full length, which furnishes ample light and ventilation. The saloon is finished in white, touched up with gold, giving a handsome effect. On the promenade deck are also located seven state rooms and the ladies' toilet room. The main stairway on this deck is of artistic design, constructed of hard wood. The dining saloon, social hall, news stand, and purser's office are located aft on main deck. The gentlemen's toilet and engineers' rooms are also located on this deck abreast of the engine space, and the forward part of this deck is reserved for freight and has a capacity of 100 tons. The captain's and mate's quarters are located on the hurricane deck just aft of the pilot house. The crew's quarters and the bar are below the main deck, forward. The galley, pantry, and refrigerator room are located below the main deck, aft.

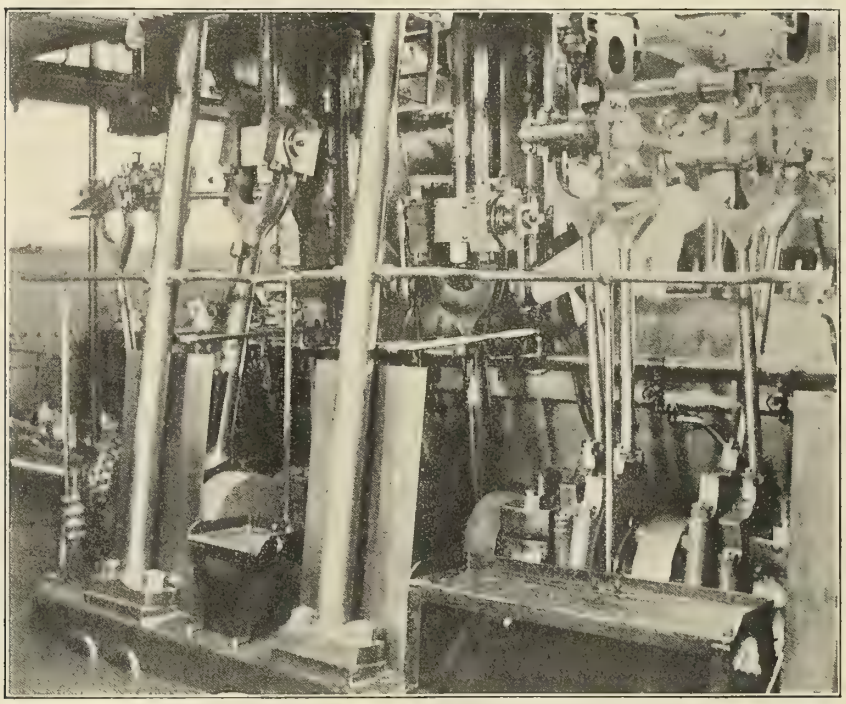
The propelling machinery develops 1,000 I.H.P. and consists of a fore-and-aft triple-expansion engine with cylinders 16, 25, and 42 inches diameter and a common stroke of 30 inches. The high and intermediate cylinders are fitted with piston valves, one to the former and two to the latter. The low-pressure cylinder has a double slide valve with a balance cylinder. The valves are worked by the Stephenson's gear, which is, with the throttle valve, controlled from a working platform situated below the engine-room grating. The condenser forms a part of the engine housing and contains 1,466 square feet of cooling surface. The air pump together with two bilge pumps are worked from the intermediate crosshead. The crank shaft is of the built-up type and measures 8 1-4 inches diameter.

There is a cast-iron, four-bladed, solid type propeller, 8 feet 6 inches diameter. The leading edges of the blades are skewed forward, beginning at hub and gradually decreasing toward the tips. The tips of the blades are raked back 5 inches. Steam is supplied by

four main boilers, single-end Scotch type, and one vertical donkey boiler. The former were tested for 180 pounds and the latter for 110 pounds working pressure.

tal duplex type and of the Blake manufacture. The electric-light plant, with capacity for supplying 600 lights of 16 C. P. and 110 volts, is of the General Electric Com-

MAIN SALOON, LOOKING FORWARD, ON THE STEAMER QUEEN CAROLINE.



MAIN ENGINE OF THE QUEEN CAROLINE, BUILT BY THE BALTIMORE SHIPBUILDING AND DRY-DOCK COMPANY.

The total grate surface in the main boilers is 120 square feet and the heating surface 3,026 square feet, giving a ratio of 1 to 25. The circulating pump and engine were made by the Kingsford Foundry and Machine Company.

The fire, feed, and sanitary pumps are of the horizon-

pany's make; it is located in the engine room on the starboard side near the after bulkhead, on which is located the main switchboard. Two small panel switches are located in the main saloon on the after ends of stateroom tiers. Of the 300 lights distributed over the vessel,

several are grouped into clusters in the main saloon and dining hall.

The *Queen Caroline* was the first boat built by the Baltimore Shipbuilding and Dry-dock Company, which is the successor to the Columbia Iron Works. The site is adjacent to the historic Fort McHenry on Locust Point, at the entrance to Baltimore harbor, well located and convenient to shipping and railroads. Extensive improvements are being made and much machinery is being installed to make this plant up-to-date. The company has lately rebuilt the steamer *Hero* and is now building two large steel barges.

Oil Burning with Induced Draft.

A test of a Scotch boiler equipped with Ellis and Eaves system of induced draft was recently attended by a number of engineers at Sheffield, England, where an evaporation of 16.1 pounds from and at 212 degrees was attained per pound of oil. The dimensions of the boiler are: Diameter, 12 feet; length, 11 feet; inside diameter of the two Purves furnaces, 3 feet 9 inches. It is fitted with 148 Serve tubes 3 1-4 inches diameter by 7 feet 9 inches long. Total heating surface is 12,000 square feet, and for coal burning the grate surface would be 43 square feet.

The oil was supplied to each furnace by Rusden and Eeles burners, the jet of flame impinging against the brick pillar and thence diffusing throughout the body of the brick-lined furnace tube. The feed water was taken from two measuring tanks, and oil was measured in two similar tanks and supplied at 75 degrees F.

The induced draft equipment consisted of an air-heating box, through which the gases from the furnace passed on their way to the fan. Fresh air is taken into this box around tubes, where it is heated to about 360 degrees F., and led down and into the furnaces. By regulating the fan and the burners the boiler is easily controlled for working under a light or heavy load.

The six-hour test gave the following results:

Water evaporated per hour, actual.....10,891 lbs.
" " " " from and at 212 degrees F.....13,145 "
Water evaporated per pound of oil, actual....13.4 "
" " " " " from and at 212 degrees F.....16.1 "
Water evaporated per sq. ft. of H.S., actual... 9 "
" " " " " " from and at 212 degrees F.....10.9 "

Theoretical heating of the oil burners will give an equivalent evaporation of 212 degrees F. of 19.14 pounds, showing the efficiency of the boiler to be 84 per cent. No smoke was emitted from the chimney during this test, and in three hours' subsequent test, which was to ascertain the maximum evaporation possible in such a boiler with oil fuel without producing smoke, a total of 18,900 pounds from and at 212 degrees was evaporated per hour. In this test the evaporation per pound of combustible was slightly reduced—namely, to 15.8 pounds. The oil used was from the Beaumont field and has a heating value of 18,450 B.T.U.

The tests show how high the ordinary marine type of boiler may be forced and still be efficient by the use of oil fuel, an amount of steam equivalent to 1,200 I.H.P. being generated in this size boiler.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING.

TRIALS OF THE HOHENSTEIN BOILER.

In the annual report of Rear Admiral George W. Melville, Chief of the Bureau of Steam Engineering, is contained the report of a board appointed to conduct a series of tests on the Hohenstein marine boiler. The boiler was built by the Oil City Boiler Works Company, of Oil City, Pa., to conform with the specifications for the cruiser *Denver*. The boiler was erected in an air-tight steel house, the dimensions of this house approximating to one of the fire rooms of the *Denver*. The headers of the boiler are made of wrought steel, and the tubes are arranged in pairs in such a way that each tube is free to expand independently of the others, thus effectually preventing longitudinal stresses in them. On page 642 is given a longitudinal section boiler, and it is to be noted that the down-flow takes place within tubes which are located in a comparatively cool place, while on the other hand there is invariably an upward trend to the current in all tubes and heaters exposed to the hot gases. It is, therefore, probable that there are no reverse currents in any part of the water circuit. The feed water is introduced at the top of the down-take tubes, which is obviously the best place with regard to the influence of the circuit.

The structure in which the boiler was mounted is air-tight, and the auxiliary machinery, together with the apparatus for making observations and measurements, was mostly placed in an adjoining structure. For forced draft a fan 72 inches in diameter, with a discharge 20 by 42 inches, was run by a separate steam engine. The pipe connections were such that steam from the auxiliaries could be taken either from a small upright boiler or from the main boiler. The feed water was weighed in two tanks, each of 1,000 tons capacity, and heated by a steam coil. The coal was weighed in sheet-metal cans or bags, the method being to adjust each can or bag to a uniform weight of 220 pounds. The ashes and refuse were also weighed. The quality of the steam was determined by means of a Barrus throttling calorimeter, and analyses of the flue gases were regularly made by using an Orsat apparatus, upon samples drawn from the center of the stack. During each test samples of the coal used were set aside for determining moisture and other analyses.

The first six tests were run by a crew of firemen experienced in torpedo-boat work, but the remaining eleven were made by firemen who had never before fired a boiler under forced-draft conditions.

Careful examination of the boiler after each of the tests showed no distortion of the tubes, nor any damage to the boiler. The boiler was given very hard work, but in the severe trials showed no indication of injury. No leak developed and not a tube bent. The tubes were frequently examined, and they were clear from mud, showing that a good circulation had been maintained.

The board, which was composed of the three Lieutenant-Commanders, John R. Edwards, Wythe M. Parks, and Frank H. Bailey, recommended that, in order to assist in discovering an approved type to meet the requirements of the navy, the Hohenstein boiler be installed on an American warship.

A summary of results is as follows:

Number of trial.	Date of trial.	Duration of trial (hours).	Kind of fuel (P., Pocahontas coal; N. R., New River coal; r. m., run of mine; h. p. s., hand picked and screened).	State of weather.	Height of barometer at noon.	Steam pressure by gage; corrected for water level, pounds per square inch.	Revolutions of blower per minute.	Average temperature.					Fuel.	
								External air (Deg. F.).	Air in fire room (Deg. F.).	Chimney gases (Deg. F.).	Feed water entering boiler (Deg. F.).	Steam at gage pressure (7) from steam tables (Deg. F.).	Weight of wood used in starting fire (pounds).	Weight of coal used in starting fire (pounds).
1	2	3	4	5	6	7	15	16	17	18	19	20	21	22
	1891.													
1....	April 23	8	P., r. m.....	Clear.....	30.02	263.9	0	57.2	93.8	594	144	410.4	350	2,400
2....	April 26	6	"	Dull and overcast.....	30.12	272.9	250	70.3	117 8	751	145.4	413.3	300	2,000
3....	May 8	4	"	"	29.86	274.6	335	72.8	121 7	1,089	145 8	413.7	390	2,500
4....	May 29	8	"	Squally.....	29.70	271.3	0	64.4	114	688	137	412.7	340	2,000
5....	June 5	6	"	Bright and sunshiny.....	30.08	272.5	243	84.1	139.5	712	129.3	413.1	360	2 200
6....	June 8	3½	"	"	29.95	270.5	375	74.8	127 3	1,105	116.5	412.5	(?)	(?)
7....	Oct. 21	8	N. R., r. m..	Clear.....	30.34	273.5	0	71 3	144	563	131.8	413.6	360	2,000
8....	Oct. 23	6	" ..	Cloudy	29.95	273.5	243	74.3	124	654	126.1	413.6	250	1,910
9....	Oct. 26	4	" ..	Smoky	30.25	273.5	375	68	106.5	688	111.8	413.6	361	2,200
10....	Nov. 6	8	P., h. p. s....	Clear and damp.....	30.20	273.5	0	62.7	125	548	125.9	413.6	350	2.792
11....	Nov. 9	8	"	Cloudy, occasional sun ...	30.18	273.5	0	55.1	125.4	521	122.3	413.6	350	1,435
12....	Nov. 18	6	"	Gray and overcast.....	30.09	273.5	240	52	105	580	119.7	413.6	350	2,762
13....	Nov. 27	4	"	Thin clouds.....	30.23	273.5	375	40.2	86	717	91.4	413.6	310	2.762
14....	Dec. 16	6	"	Smoky, with thin clouds .	30.13	273.5	243	32.3	77	766	104.6	413.6	350	3,256
15....	Dec. 18	8	"	" ..	30.01	273.5	0	26	87	568	125	413.6	360	2,440
16....	Dec. 21	4	"	Smoky, no clouds.....	30.28	273.5	332	22	64	800	98 4	413.6	450	3,130
	1892.													
17....	Jan. 11	3	"	Dark, fog and smoke.....	29.58	273.5	423	35.4	76.5	943	88	413.6	350	3,554

Number of trial.	Approximate fire-room air-pressure.	Fuel.											Steam.	Water.			
		Weight of coal used during test (pounds).	Total weight of fuel used (pounds), (21) + (22) + (23).	Weight of ashes before beginning test (pounds).	Weight of ashes during test (pounds).	Weight of refuse from furnace, tubes, baffles, etc. (pounds).	Total weight of ashes and refuse (pounds), (25) + (26) + (27).	Percentage of ashes and refuse, (28) ÷ (24) × (100).	Weight of ashes and refuse from coal used during test (pounds), (23) × (29) ÷ 100).	Percentage of moisture in coal (*by weighing and drying sample; †by chemical analysis.)	Weight of moisture in coal used during test (pounds), (23) × (31) ÷ 100.	Weight of dry coal burned during test (pounds), (23) − (32).	Weight of combustible burned during test (pounds), (33) − (30).	Quality of steam.	Total weight of water fed to boiler (pounds), (corrected for inequality of water level and steam pressure at beginning and end of test).	Equivalent weight of water evaporated into dry steam (pounds), (37) × (35).	Factor of evaporation (H − h) ÷ 965.7.	Equivalent weight of water evaporated into dry steam from and at 212° F. (pounds), (38) × (39).
1	8	23	24	25	26	27	28	29	30	31	32	33	34	35	37	38	39	40
1....	0	9,720	12,470	260	377	640	1,277	10.24	995	*0.50	49	9.761	8,676	0.980	76,016	74.555	1.134	84.430
2....	1	10,445	12,745	160	575	550	1,285	10.08	1,053	*.50	52	10,393	9,340	.968	86,673	81,260	1.133	92,060
3....	2	10,569	13,459	195	459	815	1,469	10.91	1,153	*.50	53	10,516	9,363	.989	79 803	78,700	1.133	89,170
4....	0	8,633	10 973	175	226	549	950	8.66	747	†.79	68	8,565	7,818	.990	77.953	77,120	1.142	88,070
5....	1	10,695	13,255	200	1,038	539	1,777	13.40	1,432	†.79	85	10,610	9,178	.988	92,458	91,300	1.150	104.740
6....	2	8 461	8,461	(?)	591	626	1,217	14.37	1,216	†.79	67	8,394	7,178	.990	60,539	59.800	1 163	69,540
7....	0	8,056	10,416	198	485	561	1,244	11.95	963	*3.14	253	7,803	840	.986	68.415	67,450	1 147	77,360
8....	1	9,698	11,858	161	365	528	1,054	8.89	862	*3.14	304	9.394	8.532	.976	80,747	78,800	1.153	90,950
9....	2	9,000	11,561	152	391	732	1.275	11.03	993	*3.14	283	8,717	7 724	.980	71,644	70,200	1.169	82.070
10....	0	8,299	11,441	225	214	526	965	8.44	700	*2.04	169	8,130	7 430	.988	70,148	69.300	1.154	79.980
11....	0	7,436	9,221	303	584	356	1,243	13.48	1.003	*1.15	85	7,351	6,348	.987	65 430	64,570	1.157	74,710
12....	1	8,388	11.500	526	837	562	1,925	16.75	1,405	*1.59	134	8,254	6.849	.983	70.273	69,070	1.159	80.060
13....	2	10,694	13,766	267	460	936	1,663	12.08	1,292	*1	107	10,587	9 295	.979	86,194	84.370	1.189	100.320
14....	1	14 029	17.635	271	714	923	1,908	10 82	1,518	†.73	102	13.927	12.409	.980	108.763	106,580	1.176	125,350
15....	0	9,181	11 981	235	702	576	1,513	12.63	1,160	†.73	67	9,114	7,954	.985	81,018	79 790	1.155	92.160
16....	2	12,612	16,192	105	646	895	1,646	10 18	1,285	†.73	92	12 520	11,235	.978	92,423	90.390	1.182	106,840
17....	3	10,862	14 766	151	254	1,355	1,760	11.92	1,295	†.73	79	10,783	9,488	.974	77,857	75,820	1.193	90,450

SUMMARY OF SEVENTEEN TESTS OF THE HOHENSTEIN

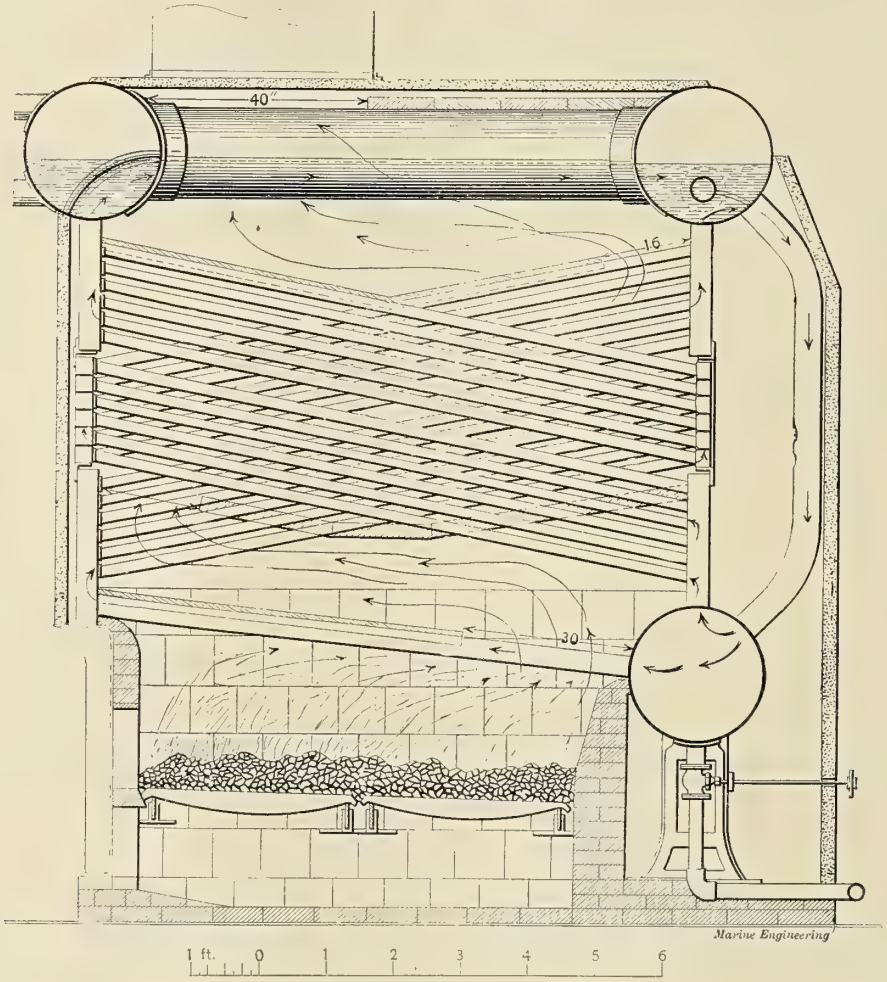
Number of trial.	Approximate fire-room air-pressure.	Economic results.				Fuel per hour.				Water per hour.				Chimney gas analysis.			
		Feed water per pound of coal as fired (pounds), (37) ÷ (23).	Equivalent evaporation from and at 212° F. per pound of coal as fired (pounds), (40) ÷ (23)	Equivalent evaporation from and at 212° F. per pound of dry coal (pounds). (40) ÷ (33).	Equivalent evaporation from and at 212° F. per pound of combustible (pounds), (40) ÷ (34).	Coal as fired per hour (pounds), (23) ÷ (3).	Dry coal per hour (pounds), (33) ÷ (3).	Combustible per hour (pounds), (34) ÷ (3).	Coal as fired per hour per square foot of grate (pounds), (45) ÷ 50.14.	Feed water per hour (pounds), (37) ÷ (3).	Equivalent evaporation from and at 212° F. per hour (pounds), (40) ÷ (3).	Equivalent evaporation from and at 212° F. per hour per square foot of grate (pounds), (53) ÷ 50.14.	Equivalent evaporation from and at 212° F. per hour per square foot of heating surface (pounds), (53) ÷ heating surface.	Carbonic acid CO_2 (per cent.).	Oxygen, O (per cent.).	Carbonic oxide, CO (per cent.).	Nitrogen, N (per cent. by difference).
1	8	41	42	43	44	45	46	47	48	51	53	54	55	56	57	58	59
1....	0	7.82	8.69	8.73	9.74	1 215	1,209	1,085	24.2	9,502	10,554	210	4.85	9.85	6.85	1.67	81.63
2....	1	8.30	8.81	8 86	9.86	1,741	1,732	1,557	34.7	14,446	15,343	306	7.05	9.46	6 50	1.96	82.08
3....	2	7.55	8.44	8.48	9.52	2.642	2,629	2,341	52.6	19,951	22,292	445	10.25	12.42	4 85	1	81 73
4....	0	9.03	10.20	10.28	11.26	1.679	1,071	977	21.5	9,744	11,009	219	5.06	11.08	4.75	2.19	81.98
5....	1	8.65	9 79	9.87	11.41	1,782	1,769	1,530	35.5	15,410	17,457	348	8.03	10.35	5.03	2.20	82.42
6....	2	7.15	8.22	8.28	9.69	2,417	2,398	2,051	48.2	17,297	19,869	396	9.14	13.77	3.73	.93	81.57
7....	0	8.50	9.60	9.91	11 30	1 007	975	855	20.1	8,552	9,670	193	4.53	9.26	6 48	1.52	82.74
8....	-	8.33	9.38	9.68	10.66	1.616	1.566	1.422	32.2	13.458	15,158	302	7.11	8.87	6.94	1.59	82 60
9....	2	7.96	9.12	9.42	10.63	2,250	2,179	1,931	44.8	17,911	20,518	411	9.64	9.20	6.40	1.70	82.70
10....	0	8.45	9.64	9.84	10,76	1,037	1,016	929	20.7	8,769	9,998	199	4.69	8.89	.....	....	.....
11....	0	8.80	10.05	10.16	11.77	930	919	794	18.5	8,179	9,339	186	4.38	8	.....	....	.....
12....	1	8 38	9.55	9.70	11.69	1,398	1,376	1,142	27.8	11,712	13.343	266	6.26	7.15	.....	....	.....
13....	2	8.06	9.38	9.48	10.79	2 674	2,647	2,324	53.4	21,549	25,080	500	11.77	8.64	.....	....	.....
14....	1	7.75	8.94	9 00	10.10	2.338	2,321	2,068	46.6	18,127	20,892	417	9.81	8.10	.....	....	.....
15....	0	8.82	10.04	10.11	11.59	1,148	1,139	994	22.9	10,127	11.520	229	5.40	7.90	11.4	.90	79 80
16....	2	7.33	8.47	8.53	9.52	3,153	3,130	2,809	62.9	23,106	26,710	533	12.54	8,90	9	1.10	81
17....	3	7.17	8 33	8.39	9.53	3,621	3,594	3 163	72.2	25,952	30,150	602	14.15	9.70	9.1	.60	80.60

Number of trial.	Approximate fire-room air-pressure.	Heat balance or distribution of the heating value of the combustible.												Efficiency.	
		Pounds of dry gas per pound of carbon $[11(56)+8(57)+7(58)+7(59)] \div [3(56)+3(58)]$.	Heat absorbed by the boiler (B. T. U.'s), (44) × 965.7.	Loss due to moisture in coal (B. T. U.'s).	Loss due to the moisture formed by the burning of hydrogen (B. T. U.'s).	Loss due to heat carried away in the dry chimney gases (B. T. U.'s).	Loss due to the incomplete combustion of carbon (B. T. U.'s).	Loss due to unconsumed hydrogen, etc., to heating moisture in air, to radiation, etc. (B. T. U.'s).	Heat value of one pound of combustible calculated from ultimate chemical analysis (B. T. U.'s).	Heat absorbed by boiler (per cent.).	Loss due to moisture in coal (per cent.).	Loss due to moisture formed by the burning of hydrogen (per cent.).	Loss due to heat carried away in the dry chimney gases (per cent.).	Loss due to incomplete combustion of carbon (per cent.).	Other losses due to radiation, etc. (per cent. by difference).	Of boiler (per cent), (61) ÷ (67) × 100.	Of boiler and furnace (per cent), 965.7 (43) ÷ B. T. U.'s per pound of dry coal × 100.
1	8	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
1....	0	21.5	9,400	7	486	2,320	1 325	1,853	15,391	61	0.1	3.2	15.1	8.6	12	61	60
2....	1	21.7	9,520	7	505	2.970	1.571	818	15,391	61.8	.1	3.3	19.3	10.2	5.3	61.8	60.8
3....	2	18.7	9.190	8	566	3,930	682	1,015	15,391	59.7	.1	3.7	25.5	4.4	6.6	59.7	58.2
4....	0	18.8	10,870	11	492	2,290	1,388	73	15 124	71.8	.1	3.3	15.1	9.2	.5	71.8	68.3
5....	1	19.8	11,020	12	487	2.400	1.569	—364	15,124	72.8	.1	3.2	15.9	10.4	—2.4	72.8	65.6
6....	2	17.2	9,360	14	564	3.570	567	1,049	15,124	62	.1	3.7	23.6	3.7	6.9	61.9	55
7....	0	23	10,910	43	555	2 050	1.265	861	15,684	69.5	.3	3.5	13.1	8.1	5.5	69.6	64.4
8....	1	23.6	10,290	44	584	2,650	1.362	754	15,684	65.6	.3	3.7	16.9	8.7	4.8	65.6	63
9....	2	23.7	10,260	46	600	2,800	1,398	580	15,684	65.5	.3	3.8	17.8	8.9	3.7	65.4	61.3
10....	0	....	10,390	27	501	.....	.....	.....	15,475	67.1	...	3.2	....	....	.....	67.1	63.3
11....	0	....	11,360	16	496	.....	.....	.....	15,475	73.4	...	3.2	....	....	.....	73.4	65.4
12....	1	....	11,290	24	516	....	.....	.....	15,475	72.9	...	3.3	....	....	.....	73	62.4
13....	2	....	10.410	15	551	.....	.....	.....	15.475	67.2	...	3.6	....	....	.....	67.2	61
14....	1	....	9.750	11	565	.....	.....	.....	15.475	63	...	3.7	....	....	.....	63	57.9
15....	0	28.1	11,190	11	521	2,740	908	105	15.475	72.2	.1	3.4	17.7	5.9	.7	72.3	65
16....	2	24.8	9,190	11	577	3,880	989	828	15,475	59.4	.1	3.7	25.1	6.4	5 3	59.4	54.9
17....	3	23.8	9,200	12	600	4,380	519	764	15.475	59.4	.1	3.9	28.3	3.4	4.9	59.4	54

MARINE WATER-TUBE BOILER, BURNING COAL.

LIQUID FUEL FOR NAVAL PURPOSES.

In this part of his report Admiral Melville states that it is now plain why success in oil burning has but recently been attained, as it is realized that oil should be atomized before ignition and that the length of the furnace, volume of the combustion chamber, and calorimeter area are factors which must be considered. In fact, it is highly probable that it may be found advisable to design a special boiler for burning oil. In view of the trifling amount of reliable data extant concerning liquid fuel, the Navy Department has projected an extended series of tests to determine the value of liquid fuel for naval purposes. These tests were started several months ago, and were conducted upon a Hohenstein boiler installed in the Washington Navy Yard, and a comparison of the results obtained with coal and oil will prove very valuable to the maritime and mercantile world.



HOHENSTEIN MARINE BOILER, ERECTED IN THE WASHINGTON NAVY YARD, WHICH WAS SUBJECTED TO EXTENSIVE TESTS.

The problem for using liquid fuel for naval purposes is quite distinct from the problem of its use in the mercantile marine, and in considering the subject the admiral has made the following divisions:

First: The engineering or mechanical feature which relates to the efficient and economical burning of oil and to the possibilities of increasing the consumption at short notice. There are many burners in the market which atomize oil quite satisfactorily. The necessity for heating the air requisite for combustion should be recognized by all who contemplate the use of liquid fuel as a combustible. Until recent years it has been impossible to get a full horse power out of a boiler when oil is used, but now that the proper method of burning oil by first atomizing it is understood, boilers may not only develop rated horse power, but may be forced so that they develop more than could possibly be done with forced draft and coal.

Second: The commercial feature relating to the question of cost and supply is not so favorable for the use of oil in battleships as in merchant vessels, because of the limited source of supply and storage of oil fuel.

Third: The structural problem relating to the installation of oil fuel on board ship is the most difficult one of the three for the navy. As the petroleum vapors are heavy, and as most of the bulk of the oil in a warship will be carried in the double bottom, it will be difficult to free the compartments of explosive gases; and by reason of the great number of electrical appliances in use on board, thousands of sparks are likely to be caused, any one of which might result in an explosion and set the oil on fire. The Bureau has no hesitation, however, in recommending that an installation should

be effected without delay on at least a third of the torpedo boats and destroyers.

REPORT OF LIEUTENANT WARD WINCHELL ON THE VOYAGE OF THE MARIPOSA.

The steamship *Mariposa,* belonging to the Ocean Steamship Company, was, during the early months of the year, equipped with new engines and boilers, and as she was about to be completed the owners decided to install oil burners on the boilers. The vessel is of the dimensions given in the following table and was built at the Cramp yard in 1883.

Lieutenant Winchell was detailed by the Bureau to make a trip on the *Mariposa* from San Francisco to Tahiti. Only two double-end boilers were used on the trip out and back. The oil tanks are constructed out of old coal bunker space forward of the boilers, and have a total capacity of 6,338 barrels, or 905.4 tons. To fill the tanks a horizontal duplex pump 6 by 8 1-2 by 10 inches was placed in the forward fire room. There are two service or settling tanks placed in pockets formed on either side of the single-end boiler. Each tank holds about twelve hours' supply. They are filled by the oil-tank pump and have overflow back to the main pumps. There are two oil-service pumps with duplex cylinders 6 inches and 4 inches by 6 inches stroke, each one being large enough to supply all the burners. These are both placed in the forward fire room and draw their supply from the settling tanks through removable strainers, and discharge into the bottom of a small heating tank, where the oil is heated by a steam coil to not more than 150 degrees, and thence by a pipe is taken to the burners. The double-acting duplex air pump, with steam cylinders 12 inches, air cylinders 22 inches, and a common stroke of 18 inches, is placed in a pocket on the upper engine-room platform, and the air discharges into the top of the heater tank on its way to the burners, so that the oil and air go to the burners under the same pressure, which is limited to 40 pounds. The burner is of the Grundell and Tucker type and consists of a hollow plunger for the oil, screwed into a pipe through which the air passes. The outlet for the oil is through a series of small holes at right angles to the central hole. The air meets the oil through spiral directors and is sprayed into a rose shape by the expanded end of the atomizer. The air and oil pipes have globe valves for regulating the supply of either, also plug cocks for shutting off the burner immediately. The air-supply pipe is also connected to a steam line, so that steam may be substituted for air if desired. The length of the oil plunger is adjustable to give the best form to the flame. Two burners were fitted on each boiler. The air is heated on the way to the burners by passing through a hollow iron casting in the front of each furnace. In the lower part of the furnace front is a door on hinges for regulating the supply of free air.

In the double-end boilers there is a common combustion chamber for opposite furnaces. A brick bridge wall is built across these furnaces, reaching above the top line of the furnaces.

At Tahiti a careful inspection failed to show any bad effects of the flame upon the boilers. No leaks or defects developed, and the total amount of refuse swept by tube scrapers and out of the back connections and uptakes barely filled two ash buckets. This refuse, which was mainly soot, was a result not only of the twelve days' run to Tahiti but also of three preliminary trials.

No precautions other than those usually taken on board ship were made to guard against fire or explosion. All spaces to which oil has access are well ventilated by both inlet and outlet ducts. As a coal burner the *Mariposa* formerly had the following engineering force: one chief engineer, three assistant engineers, three oilers, twelve firemen, twelve coal passers, three water tenders, one messenger, one storekeeper; total, thirty-six. The fire-room force with oil burning was reduced sixteen men; and of the six firemen carried, three were relieved from watch the second day out, leaving but one man on a watch to fire twelve furnaces in two different fire rooms. The water tender did not touch the burners, except in emergency, his duty being to tend water, fill settling tanks and record the height of oil in them, record temperatures of oil at settling tank and of heater in fire room and of superheated air, take readings of the lower pyrometer where the two uptakes meet, and run oil pumps supplying oil to the settling tanks, and small oil pump supplying oil to the oil heater.

	Voyage No. 1.		Voyage No. 2.		Average
	Total.	Average.	Total.	Average.	
Knots, total	3,438		3 660		3,549.
Knots per hour		13.12		14.05	13.58
R. P. M.		65.2		70.90	68.05
I. H. P. main engines		2,193		2,770	2,481
Oil per day (bbl.)	2,803	254.8	3,277	302	278.4
Oil per day (long ton)	400.43	36.40	468.14	43.18	34.29
Oil per hour (lbs.)		3,412		4 026	3,719.
I. H. P. ÷ G. S.		8.59		10.73	9.66
H. S. ÷ I. H. P.		3.79		3	3.39
Pounds of oil I. H. P.		1.56		1.45	1.50
Pounds oil per knot.		260.9		286.3	273.6
Knots per ton oil		8.59		7.82	8.20
Knots per bbl. oil		1.22		1.11	1.16
Slip of screw in per cent		13.44		12.08	12.97
Actual time (hrs.)	263		260 1-2		

TRIAL DATA OF THE MARIPOSA.

The principal difficulties encountered were the regulation of the supply of oil to the heaters by the pump

Number of trial.	Date of trial, 1902.	Duration of trial (hours).	Kind of fuel.	Oil burner used.	State of weather.	Height of barometer at noon.	Average pressures.		Revolutions of fan blower per minute.	Average temperature (Deg. F.).		
							Steam pressure by gage; corrected for water level (pounds per square inch).	Pressure of medium used for spraying oil (pounds per square inch).		External air.	Air in fire-room.	Medium used in spraying oil.
1	2	3	4	5	6	7	8	9	15	16	17	18
1....	June 11	6	Beaumont oil.	O. C. B. W. (air).....	Bright sunny day.	30.02	273.5	3.20	327	85.4	121	(?)
2....	June 12	4	"	"	" "	30	273.5	4.62	423	86	121.5	(?)
3....	June 26	8	"	"	" "	29.70	273.5	.78	0	79	106	102.5
4....	June 27	3	"	"	Bright sun, few clouds....	29 94	273.5	3.37	483	81	108	122
5....	Aug. 2	5	"	"	Bright sunny day.....	30.13	273.5	1.41	0	87	112	120
6....	Aug. 4-9	116	"	"	(See log)....	29 89	271.5	1.31	0	79	112	113.5
7....	Aug. 15	6	"	"	Thin fleecy clouds	30.10	272.5	4.66	0	77.6	120	161
8....	Aug. 20	3	"	"	Smoky, occasional clouds.	30.08	276	4.68	506	82	115	136
9....	Sept. 12	6	"	Hayes (steam).....	Partly cloudy.	30.16	273.5	32	0	75	98	(?)
10....	Sept. 19	8	"	O. C. B. W. (steam).....	Thin clouds.....	30.20	273.1	29.9	0	69	98	444.4
11....	Sept. 20	8	"	"	"	30.18	273.7	61.4	0	77	106	408.2
12....	Sept. 22	8	"	"	Partly cloudy.....	30.05	274.2	91	0	77	103	401
13....	Sept. 27	8	"	Reed (air and steam)....	Fair.....	29.92	276.7	92	0	80.4	99.4	375
14....	Sept. 29	8	"	" "	Clear	29.96	277.4	89	0	85.4	111.5	416

Number of trial.	Approximate fire-room air-pressure (inches of water).	Average temperature (Deg. F.).			Oil.		Steam.	Water.				Economic Results.				
		Chimney gases.	Feed water entering boiler.	Steam at gage pressure (8), from steam tables.	Weight of oil used during test (pounds).	Weight of steam consumed directly or indirectly in spraying oil, in the latter case assuming 34½ evaporation units per hour per indicated horse power.	Quality of steam.	Total weight of water fed to boiler, pounds (corrected for inequality of water level and steam pressure at beginning and end of test).	Equivalent weight of water evaporated into dry steam (pounds), (26)×(24).	Factor of evaporation, $(H-h)\div 965.7$.	Equivalent weight of water evaporated into dry steam from and at 212° F. (pounds), (27)×(28).	Feed water per pound of oil (pounds), (26)÷(22).	Equivalent evaporation from and at 212° F. per pound of oil (pounds), (29)÷(22).	Pounds of steam used in spraying oil per pound of oil, (23)÷(22).	Steam used in spraying oil (per cent. of total steam generated), (23)÷(26)×100.	Cubic feet of free air used in spraying oil per pound of oil sprayed.
1	10	19	20	21	22	23	24	26	27	28	29	30	31	32	33	34
1....	1.3	704.6	120.7	413.7	10,584	2,820	0.983	117.976	115,960	1.159	134,400	11.15	12.70	0.303	2.39	34.3
2....	2.3	779	103.2	413.7	9 180	3.770	.980	96,928	94 980	1.177	111.800	10.56	12.18	.474	3.89	37.4
3....	0	503.6	128.5	413.7	6,122	827	.984	78,000	76,740	1.151	88,330	12.74	14.43	.153	1.06	62.8
4....	3.3	854	119	413.7	8,602	2,550	.981	88.604	86,915	1.161	100,900	10.30	11.73	.337	2.88	36.7
5....	0	557	129	413.7	4.668	1,153	.986	58,529	57.700	1.151	66.380	12.54	14.22	.280	1.97	70
6....	0	585	119.4	413.1	96 517	18,240	.985	1,192.482	1,174,500	1.160	1,363.000	12.36	14.12	.216	1.53	55.4
7....	0	747	119.7	413.4	9,089	7,800	.995	104 631	104,100	1.160	120,780	11.52	13.29	.990	7.45	78.3
8....	3.75	1,017	119	414.5	9.909	3,950	.988	92.997	91,870	1.161	106 690	9.39	10.77	.458	4.25	36
9....	0	449	127	413.7	3.600	2 524	.991	43,761	43.367	1.153	50.000	12.16	13.89	.701	5.77	0
10....	0	596	118.3	413.6	7.360	3.412	.995	85,791	85.350	1.162	99.170	11.65	13.47	.464	3.98	0
11....	0	628	120.2	413.8	8,257	4.252	.994	96 469	95.880	1.160	111,190	11.68	13.45	.515	4.41	0
12....	0	661	119.6	414.0	8 974	5,305	.995	105.547	105,020	1.160	121,840	11.77	13.58	.591	5.03	0
13....	0	578	121.9	414.8	7.692	8 166	.996	95.605	95,310	1.158	110,370	12.43	14.35	1.062	8.54	81.4
14....	0	645	120.8	415.0	9,216	6,838	.998	112,115	111,890	1.159	129,570	12.17	14.06	.742	6.09	78

SUMMARY OF FOURTEEN TESTS OF THE HOHENSTEIN

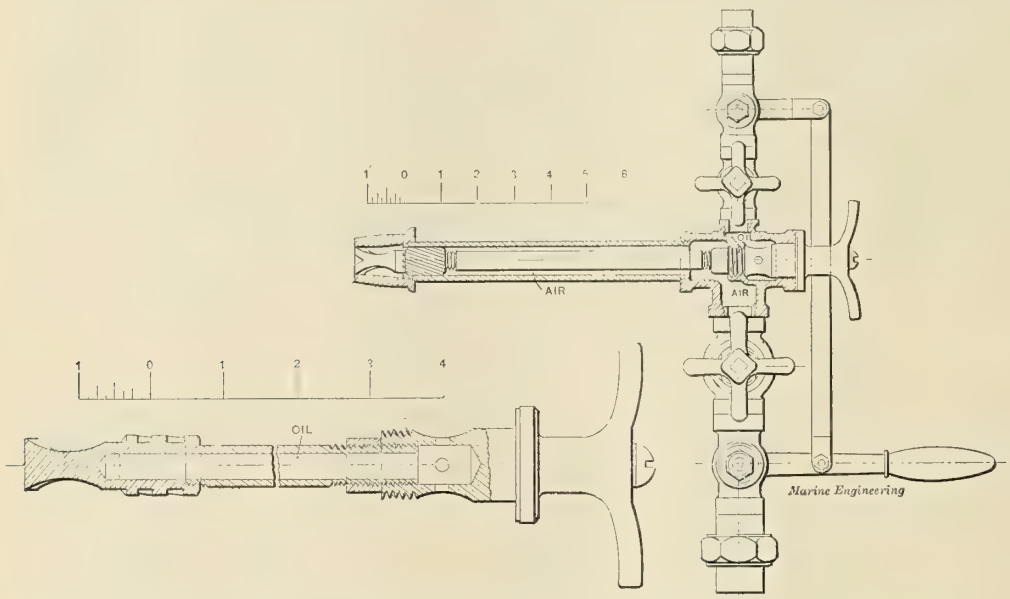
Number of trial.	Approximate fire-room air pressure (inches of water).	Fuel per hour.				Water per hour.				Chimney gas analysis.						
		Oil per hour (pounds), (22) ÷ (3).	Oil per hour per horizontal square foot of furnace (pounds), (35) ÷ 50.14.	Oil per hour per square foot of heating surface (pounds), (35) ÷ 21 30.	Steam consumed in spraying oil (pounds per hour), (23) ÷ (3).	Feed water per hour (pounds), (26) ÷ (3).	Water per hour corrected for quality of steam (pounds), (27) ÷ (3).	Equivalent evaporation from and at 212° F. per hour (pounds), (29) ÷ (3).	Equivalent evaporation from and at 212° F. per hour per square foot of heating surface (pounds), (41) ÷ 21 30.	Carbonic acid, CO_2 (per cent.).	Oxygen, O (per cent.).	Carbonic oxide, CO (per cent.).	Nitrogen, N (per cent. by difference).	Pounds of dry chimney gas per pound of carbon, $[11(44) + 8(45) + 7(46) + 7(47)] \div [3(44) + 3(46)]$.	Percentage of carbon in oil by chemical analysis.	Pounds of dry chimney gas per pound of oil, (48) × (49).
1	10	35	36	37	38	39	40	41	43	44	45	46	47	48	49	50
1....	1.3	1,764	35.15	0.83	535	19,663	19,327	22,400	10.5	6.97	8.77	1.50	82.76	28.99	83.26	24.1
2....	2.3	2,295	45.8	1.08	1,088	24,232	23,475	27,975	13.1	6.96	9.20	1.20	82.64	30.11	83.26	25.1
3....	0	765	15.25	.36	117.5	9.750	9.593	11,041	5.18	7.24	10.2	.425	82.135	32.15	83.26	26.8
4....	3.3	2 867	57.2	1.35	967	29.535	28.972	33,633	15.8	7.50	10.4	.3	81.80	31.64	83.26	26.4
5....	0	933.6	18.6	.44	262	11,706	11,540	13,276	6.23	7.70	10	.13	82.17	31.54	83.26	26.3
6....	0	832	16.6	.39	179.5	10,280	10,125	11,750	5.52	7.68	10.25	.06	82.01	31.91	83.26	26.6
7....	0	1,515	30.2	.71	1,501	17 447	17 360	20 137	9.45	10.1	6.64	.275	82.985	24	83.26	20
8....	3.75	3,303	65.9	1.55	1,511	31,001	30 629	35,560	16.7	7.87	9.66	.22	82.25	30.54	83.26	25.4
9....	0	600	11.97	.28	421	7,294	7.228	8,333	3.91	5.5	13.05	.27	81.18	42.47	83.26	35.4
10....	0	920	18.34	.43	427	10,724	10 669	12,396	5.82	6.99	11.05	.013	81.95	35.16	83.26	29.3
11....	0	1,032	20.57	.48	532	12,057	11,985	13,899	6.52	7.47	10.66	.086	81.78	32.64	83.26	27.2
12....	0	1,122	22.35	.53	663	13 193	13 128	15,230	7.15	8.44	9.29	.014	82.26	29.29	83.26	24.4
13....	0	962	19.15	.45	1,021	11,951	11 914	13.796	6.48	7.70	9.85	.075	82.37	31.70	83.26	26.4
14....	0	1 152	22.95	.54	855	14 014	13,986	16,196	7.60	8.53	9.04	.05	82.38	28.85	83.26	24

Number of trial.	Approximate fire-room air pressure (inches of water).	Heat balance, or distribution of the heating value of the oil.													Efficiency.	
		In British thermal units.							In percentages of the total heating value of the oil.							
		Heat absorbed by the boiler. (31) × 965.7.	Loss due to superheating steam used in spraying oil.	Loss due to moisture formed by the burning of hydrogen.	Loss due to heat carried away in dry chimney gases.	Loss due to incomplete combustion of carbon.	Other losses—due to unconsumed hydrogen, to heating moisture in air, to radiation, etc., by difference.	Heat value of one pound of oil, calculated from chemical analysis.	Heat absorbed by boiler.	Loss due to superheating steam used in spraying oil.	Loss due to moisture formed by the burning of hydrogen.	Loss due to heat carried away in dry chimney gases.	Loss due to incomplete combustion of carbon.	Other losses—due to unconsumed hydrogen, to heating moisture in air, to radiation, etc.	Of boiler (per cent.), [(51) ÷ (57)] × 100 = (58).	Of boiler and furnace (per cent.), (64) × $\left[1 - \frac{(33)}{100}\right]$.
1	10	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
1....	1.3	12 250	0	1,440	3.375	1,495	921	19.481	62.8	0	7.4	17.3	7.7	4.8	62.8	61.3
2....	2.3	11,760	0	1.480	3,925	1,242	1,074	19.481	60.3	0	7.6	20.1	6.4	5.6	60.3	58
3....	0	13.930	0	1,350	2.565	469	1,167	19.481	71.5	0	6.9	13.2	2.4	6	71.5	70.7
4....	3.3	11,320	0	1,540	4.720	326	1,575	19 481	58.1	0	7.9	24.2	1.7	8.1	58.1	56.4
5....	0	13,720	0	1.370	2,800	141	1,450	19 481	70.4	0	7	14.4	.7	7.5	70.4	69
6....	0	13,620	0	1,390	3,020	66	1 385	19.481	69.9	0	7.1	15.5	.3	7.2	69.9	68.8
7....	0	12,830	0	1.470	2.945	224	2 012	19.481	65.8	0	7.5	15.1	1.2	10.4	65.8	60.9
8....	3.75	10,400	0	1.620	5,480	230	1,751	19.481	53.4	0	8.3	28.1	1.2	9	53.4	51.1
9....	0	13,413	58	1,366	2,990	395	1.259	19,481	68.9	.3	6.9	15.4	2	6.5	68.9	64.9
10....	0	13.008	77	1 445	3,500	16	1,435	19.481	66.7	.4	7.4	18	.1	7.4	66.7	64.1
11....	0	12.989	79	1,458	3,410	97	1.448	19,481	66.7	.4	7.5	17.5	.5	7.4	66.7	63.8
12....	0	13,114	93	1,479	3.270	14	1,511	19.481	67.3	.5	7.6	16.8	.1	7.7	67.3	63.9
13....	0	13,857	125	1,431	3.000	82	986	19 481	71.1	.6	7.4	15.4	.4	5.1	71.1	65
14....	0	13.578	112	1,465	3,070	49	1,207	19 481	69.7	.6	7.5	15.7	.3	6.2	69.7	65.4

MARINE WATER-TUBE BOILER, BURNING OIL.

and the consequent variation of the temperature of the heated oil and the freedom of flow through the burners. If the oil is heated above 150 degrees some of the gases are driven off and mingle with the air pressing on top of the oil in the heater, thence passing with the air into the air superheater, the result being that on one occasion a heater became red hot from this cause. The air in the superheater is raised to 350 degrees. Another difficulty was due to the choking of the strainers by foreign matter and impurities in the oil. While making necessary repairs to the compressor steam was used for atomizing for two and one-half hours, when the number of turns to the main engine were but slightly reduced.

Full power was not developed in the two boilers used, as schedule time was easily exceeded with from two to four burners shut off. In the preceding table the calculations are based on the horse power of the main engines only. Cards were taken from the main engines twice a day, and the horse power for the day was calculated by comparing that of the cards with that which would be indicated at the average number of turns for the day.



THE GRUNDELL-TUCKER BURNER USED ON THE MARIPOSA.

REPORT OF BOARD ON TESTS OF LIQUID FUEL FOR NAVAL PURPOSES.

A preliminary report made by the board appointed to conduct an experimental series of tests for determining the value of liquid fuel for naval purposes, is included in the annual report of the Chief of the Bureau of Steam Engineering. After stating the advisability of the navy's conducting the tests, the board proposes the following problems:

1. The relative advantages of air and steam as an atomizing agent for liquid fuel, and, where steam is used, the amount of superheat that should be applied.
2. The pressure at which oil, steam, and air should be delivered to the burners.
3. The design of steam generator.
4. The simplest and most economical means of heating the air and oil, as the board believes there is no doubt but the air should be heated.
5. The value or necessity of a receiver when compressed air is used.
6. The necessity of baffling plates for the gases.
7. The relative value of the leading types of burners.
8. Whether oil can be consumed under all conditions without producing smoke, which is of special importance to the navy.

The plant used for testing was that on which the coal-evaporative tests of the Hohenstein boiler were conducted, with necessary connections of steam, oil, and air for operating the burners. The feed water and fuel oil were weighed in receiving tanks; the air for atomizing was supplied by a Root blower, and the oil used was from the Beaumont field and had probably been subjected to an inexpensive treatment which removed the sulphur and some of the more volatile hydrocarbons. The board believes, from knowledge at hand, that this oil is preferable to crude oil. The calorific value of the oil was given at 19,481 British thermal units.

The temperatures at the base of the stack were remarkably free from the rapid fluctuations which characterized coal-burning trials.

In making the tests of the different burners, the following points were ascertained: The evaporative efficiency of oil was compared with coal under like conditions; the degree to which the combustion of oil could be forced with both steam and air, with natural and forced draft; the ability of a burner to work under forced-draft conditions; the liability of injury to the boiler; the amount of steam or air requisite for atomizing; the amount of pressure which should be applied; the effect of heating the entering air; the time required to train men to operate the burners; means for reducing the noise of the burners, and the attitude of the firemen as regards operating oil installation.

During an endurance test of 116 hours the employees of the Oil City Boiler Works conducted the tests during the daytime, and the crews of the torpedo boats *Gwin* and *Rodgers* were on duty during the night watches. After some preliminary training the navy employees were able to run the boiler as successfully as the experts in the day watch.

states that in its opinion the interests of the navy and private parties will best be served by having tests conducted by persons within the navy. The report is signed by Lieutenant-Commanders John R. Edwards, Wythe N. Parks, and Frank H. Bailey. On pages 644, 645 will be found a summary of the fourteen different tests made by the board.

HOHENSTEIN WATER TUBE BOILER.

Drums at water-surface level;
One front drum,.....24 in. inside dia.
One rear drum.....24 in. dia.
Four connecting drums.....16 " "
One lower rear mud drum.....24 " "
Tube-heating surface;
Three hundred and eighty-four 2-in. tubes.....9 ft. long.
Sixteen 4-in. tubes.....7 " "
Fifteen down-take tubes.....5 in. dia.
Floor space occupied,
9 ft. wide, 10 ft. 11¼ in. deep.
Height above floor line.....12 ft. ¾ in.
Height over all.....12 " 6¾ "
Heating surface;
2,174 sq. ft. for tests No. 1 to No. 6, inclusive.
2,130 " " " " 7 " " 17 "
Per cent. water-heating surface.....100
Grate surface:
50.14 sq. ft., 6 ft. 4 in. long, 7 ft. 11 in. wide.
H. S. ÷ G. S.;
43.4 to 1 for tests No. 1 to No. 6, inclusive.
42 5 to 1 " " " 7 " " 17 "
Volume of water at steaming level...142 cu. ft.
Volume of steam space.....50 " "
Area of steam liberating surface.....75 sq. ft.

Weight of water at steaming level and 275 pounds pressure .....7,559 lbs.
Weight of boiler and fittings, excluding uptake and smoke pipe;
Without water.....46,568 lbs.
With water.....54,127 "
Without water, per sq. ft. of H. S.:
21.4 lbs. for tests No. 1 to No. 6, inclusive.
21.8 " " " " 7 " " 17 "
With water, per sq. ft. of G. S.....1,080 lbs.
Height of furnace.....2 ft. 5 in.
Volume of furnace above bars.....121.14 cu. ft.
Width of air spaces between grate bars;
Five-eighths inch
for tests No. 1 to No. 11, inclusive.
Three-fourths inch
for tests No. 12 to No. 17, inclusive.
Ratio of grate area to area of air space:
1⅛ : ⅝ = 1 : 0 555
for tests No. 1 to No. 11, inclusive.
1¼ : ¾ = 1 : 0 60
for tests No. 12 to No. 17, inclusive.
Height of smoke pipe above grate.....70 ft.
Area of smoke pipe.....8.73 sq. ft.
Ratio of smoke-pipe area to grate area.....1 : 5.75.
Number of fire doors.....3

NAME—Mariposa. NATIONALITY—American. BUILDER—Wm. Cramp and Sons.

LAUNCHED—1883. OWNER—Ocean Steamship Co. TYPE—Ocean Steamer.

RE-ENGINED—Risdon Iron Works, 1902.

Length between perps.....314 ft.
Beam, molded ..... 41 "
Depth, " .....17 ft. 3 in.
Load draft.....22 ft.
Propeller.....4 blades
Diameter .....16 ft. 6 in.
Pitch.....23 ft.
Engine.....triple expansion
Diameter cylinders.....29, 47, 78 in.
Stroke .....51 in.

Boilers.....two double end; one single end
Type .....Scotch
Length.....17 ft. 3 in.; 19 ft. 9 in.
Diameter.....15 " 3 " 14 "
Number of furnaces..... 6 3
" " comb. chambers..... 3 1
G. S. (two double-end)..... 516 sq. ft.
H. S. (two double-end).....16,604 " "

In making tests of the various burners it was found necessary to allow the different makers to conduct preliminary trials, as the problem of fitting burners to a boiler capable of developing 2,000 horse power was a different matter from installing the burner on a small boiler.

The board recommends the immediate installation of oil-fuel appliances on two torpedo boats and two destroyers for testing the adaptability of oil with water-tube boilers of the bent-tube type, and in conclusion it

Saving a Derelict.—The Yankee schooner *R. B. Woodside,* which was abandoned in a sinking condition on February 26, 1901, as the official report states, was recently towed into Abaco, New Providence, after having drifted 8,000 miles about the Atlantic. The crew had been taken off the schooner, which was bound from Jacksonville to New York, by a passing steamer, and since then the derelict has been frequently sighted in various places on the ocean, and has been a great source of danger. She was recently sighted 400 miles from the Bahamas and towed into the above-named port.

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THE subjects of the papers read at the annual meeting of an engineering society should be a reflex of the questions and problems which are chiefly to the fore in such fields of engineering work. If such is the case, the chief questions of importance in the field of marine construction are the design, construction, and armament of naval vessels, the balancing of engines, vibrations of steamships, steamship trials, courses of education for naval architects, the geometrical theory of naval architecture, the applications of electricity on shipboard, the strength of ships, water-tube boilers, and rules for yacht measurement.

Such, in any event, is the character of the programme of the papers for the annual meeting of the Society of Naval Architects and Marine Engineers held on the 20th and 21st of last month. Whether or not all of these questions are of the importance which their place on the programme might seem to indicate is a question of opinion or judgment; but, in any event, the programme as a whole must be taken as a general indication of the topics considered most important by those members having the inclination to present papers for the consideration of the society. As usual, we present this month as a special feature a careful synopsis of the papers read at this meeting, together with the more important points brought out by the discussion. This will enable our readers to form an excellent idea regarding the general character of the meeting, the papers presented, and the discussion provoked. Looking at the matter from an impartial viewpoint, it may fairly be said that the discussion of the papers leaves, as a rule, something to be desired, and, secondly, that there is a lack of papers of definite and permanent technical value to the profession at large. The character of the discussion seems to result from the fact that the average American engineer is too busily occupied to take the time for a careful study of the papers before the meeting and for the preparation of an illuminating discussion. It is always the case, furthermore, that some of the papers are in hand too short a time before the meeting to permit of the study necessary for such a discussion. The secretary cannot perform the impossible, and so long as human nature remains what it is, so long will papers come in at the eleventh hour, thus preventing the preparation of any adequate discussion. Even if the papers were distributed to the members a month before the meeting, we are not sure to what extent this would tend to produce more carefully prepared discussion of the points presented.

Regarding the character of the papers, they are, of course, the product of the surroundings in which their authors are occupied and of the influences which necessarily react on the character of the paper; and among such influences none is perhaps stronger than the commercial. This acts as a limitation or restriction and prevents the author from giving to his colleagues the very points regarding his own work which they are most anxious to know, and in many cases to remove from his paper all description of the ways and means whereby given results are attained, and to reduce it to a mere statement of results without reference to the steps by which they have been reached. There is, of course, room for descriptive papers or for those which simply record results. Such have their historical value and serve as a record of progress; but while it is hardly to be expected that the detailed results of large investments of time and money shall be freely given to the profession at large, it may be fairly questioned whether some larger proportion of matter of direct technical value might not be included in many such papers without any serious hazard to the commercial interests involved.

THE annual report of Rear Admiral Melville, Engineer-in-Chief of the Navy, comes to hand, freighted as usual with its vigorous discussion of all matters relating to engineering in the Naval Service, and its rich fund of information regarding the routine and experimental activities of the Bureau during the year. Chief among the latter is found a detailed account of recent tests with the Hohenstein type of water-tube boiler, carried out with both coal and liquid fuel. In the latter case the experiments constituted a most exhaustive and valuable study of the capabilities of liquid fuel, especially as applied to the water-tube type of boiler.

Regarding the general question of water-tube boilers, the report states the main points of advantage of the water-tube type for the Naval Service, and points out the desirability of continuing the "trying out" process in order to learn by actual experience the types and forms best suited to the requirements of the service. For the battleships now in course of construction, water-tube boilers of three types are contemplated—the Babcock and Wilcox, Niclausse, and Thornycroft. A new type, known as the Hohenstein, was submitted to the Bureau for test early in 1901, and since that time has served as the basis of a most extended series of tests, both as a water-tube boiler and as a steam generator for use with various systems for burning oil fuel. As a result of the trials, so far as they relate to the boiler, the type has been approved and recommended for installation on some ship building for the Naval Service. We have before referred in these columns to the wisdom underlying this policy. It is very sure that no one water-tube boiler can be the best for all conditions of service, nor is it to be assumed that any particular one should at the present time be selected as a sole standard or be considered as having reached a final stage of development. Rather, it is sure that the problem of the water-tube boiler can only be solved by a process of selection among the most promising types, such selection being made under actual working conditions at sea.

The report gives also extended reference to the subject of oil fuel, liberal extracts from which will be found on another page of the present issue. Taken as a whole, the report maintains the high standard which we have been led to expect by the similar reports of preceding years, and its careful perusal may be recommended to all who are interested in the welfare of the Naval Service.

WE have shown on another page a cut of the United States naval fleet in European waters in 1872. The advance in engineering progress from day to day, or even from year to year, seems so slow to those who are engaged in the work that it is well at times to take a more general view of the distance covered in a considerable period of years, the better to appreciate how significant and how great the sum total of the daily steps becomes when allowed to accumulate through such a length of time. The engineer is a man who naturally looks forward, ever striving for the advancement of his profession. A retrospect is, however, sometimes useful, in order that he may the better note the trend of the lines of progress and the better adjust himself to the future as derived from the past. The machinery of the United States fleet of 1872 will furnish to the thoughtful engineer abundant food for a retrospect of this character. The engines were all small, of 500 to 1,000 I.H.P., using steam pressures of 30 to 50 pounds, and with boilers to suit. The compound engine was just then appearing prominently above the horizon, and the Engineer-in-Chief had shortly before returned from an extended visit in Europe, where he had observed such examples of compound engines as came under his notice, and on his return recommended in his annual report the adoption of this type of engine for naval service.

About this same time the department had ordered the removal of all four-bladed screws from such ships as were fitted with them, and their replacement by two-bladed screws, in order to improve the handling of the ships under sail. To this action strong objections were made by the Engineer-in-Chief, but to no avail, and the steaming capacity of the ships was therefore sacrificed in order that they might stand a better chance of manœuvering under sail in squadron with sailing ships, without being distanced by the older ships adapted to propulsion by sails alone.

We have no intention of developing any extended comparison with the present, as interesting and instructive as such comparison might be made in points of detail. A realizing sense of progress is often gained by quick glances at the extremes of the period under consideration, and in this case the bare statement of facts, and the thought that these facts relate to a period just about a generation ago, are quite sufficient to show how profound has been the change and how great the progress in that period.

PRACTICAL POINTS IN SHIPBUILDING.—II.

BY EADS JOHNSON.

ANGLEWORK.

After the major part of a ship's framework has been completed, including frames, reverse frames, beams, keelsons, stringers, gunwale and waterway angles, etc., the small anglework, including clips, lugs, and staples, brings out many forms of angles, among them such as

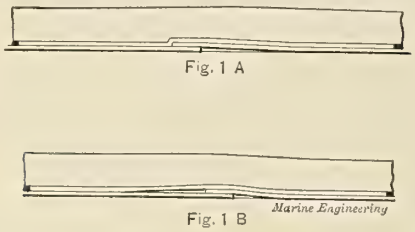

Fig. 1 A

Fig. 1 B

are shown by the accompanying sketches. The working of the straight angle into these shapes necessitates clever smithwork, in return for which an anglesmith working on the piecework system draws good pay. The most common form to which an angle is smithed is in the case of an offset over a lap or butt strap, as shown in Fig.

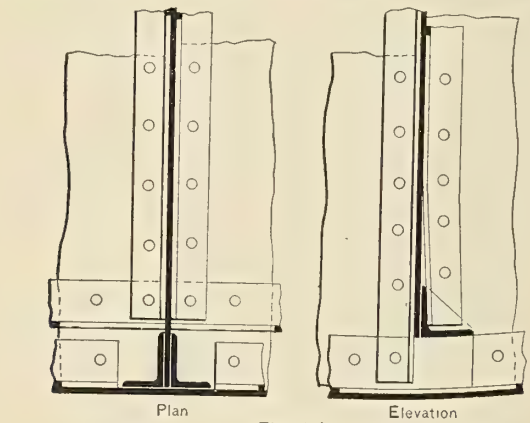

Fig. 2 A

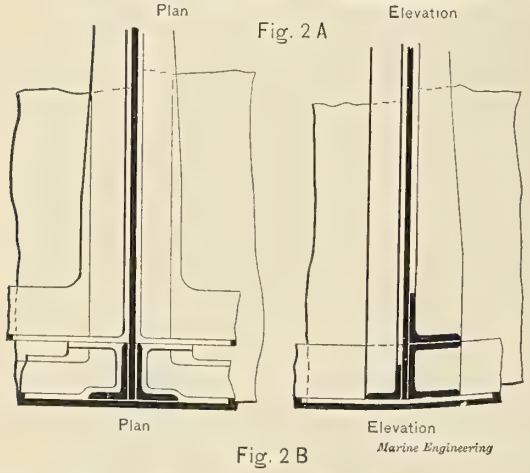

Fig. 2 B

1 *A*. Where a neat or water-tight job is required, as with a bulkhead-bounding angle, in way of a lap of the deck plates, the angle is worked in this manner. When water-tightness is not essential the angle may be run over as shown in Fig. 1 *B*, and a small tapered liner used.

Fig. 2 *A* shows an elevation of a bulkhead frame, beam, bracket, and section of stringer angle. The bulkhead being non-water-tight, the bounding angle runs into the bosom of the stringer, a tapered liner being used. Fig. 2 *B* shows where the bulkhead is water-tight, and the stringer, instead of running through the bulkhead, is turned around and makes a butt with the bounding angle; the shell clip gives way to a small staple between the stringer and shell, thus giving available calking edges.

Where the side or sister keelson angles are riveted

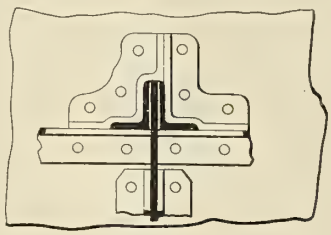
Fig. 3

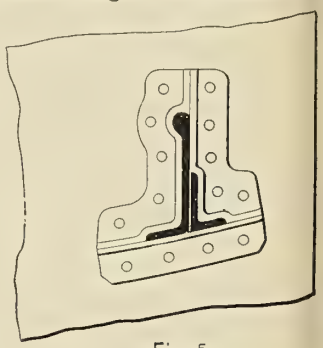
Fig. 5

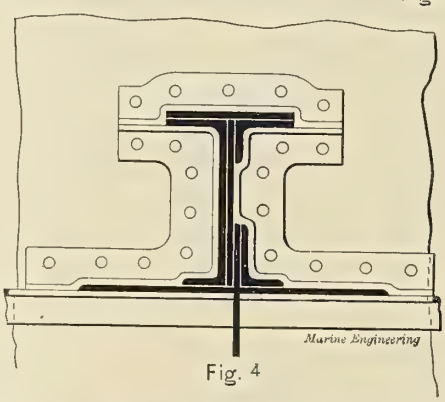

Fig. 4

back to back, as in Fig. 3, a shoe is made to fit the shape of the angles. This is placed usually on but one side of the bulkhead, a plate collar being used on the other side. Where the bulkhead is subject to pressure, as in the fore or after peak tank, a shoe staple is used on both sides.

When the center keelson runs through a water-tight bulkhead a staple such as in Fig. 4 is necessary for fitting around the keelson, angles, stringer, and rider plate. The staple may be made to fit this section perfectly, but two offsets can be done away with by using a short parallel liner on one side. The side keelson is treated in a similar manner, the angle staples being made similar to those shown in Fig. 5; but where the keelsons do not run through the bulkhead, which is sometimes the case, they are cut and bracketed to the bulkhead on fore and after sides.

A peculiar form of staple, and a difficult one to make, is required when a water-tight bulkhead strikes the protective deck of a modern cruiser or battleship. Here, as illustrated in Fig. 6, the deck runs out to the shell and the bulkhead is continued to the shape of the protective deck. Where the deck forms the top of the fore or after peak tank a staple such as shown in Fig. 7 is necessary, in order that the deck in way of the frames and shell may be properly connected and give available calking edges. In such cases the deck stringer angle may be omitted to advantage, as the staple performs the functions of the shell clip, water-tight staple, and where

the staples overlap each other a continuous chain is formed, which is also a stringer. If the stringer angle were run along the deck and riveted to the reverse frames the staple between the frames would be as shown in Fig. 8. It is evident that calking the lower flange behind the stringer would be a difficult job, and the probable method would be riveting and calking the staple before the stringer angle is put on.

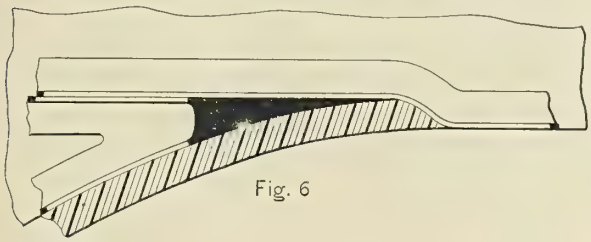

Fig. 6

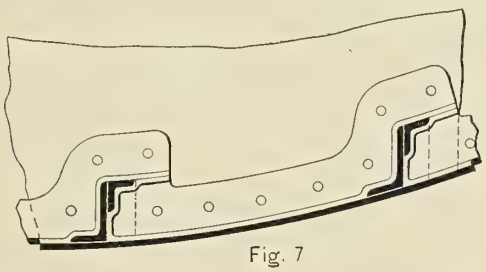

Fig. 7

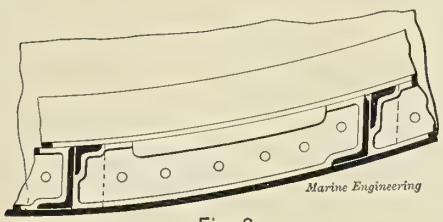

Fig. 8

Usually staples can be worked neat enough to make a good water-tight job without depending upon or resorting to any form of stopwater. In all water-tight work, however, the stopwater is more or less used, especially in jobs of poor workmanship.

COMMUNICATION.

Editor Marine Engineering:

I think the readers of Marine Engineering ought to feel very much indebted to you for calling forth and publishing the valuable letters on page 555 of the November magazine headed "Opportunities for Entering Engine-Room Service." I like the genuine ring of Mr. Carnegie's letter, and the able letter of Mr. Center, of the Pacific Mail Company, strikes the nail on the head.

How any country can ever expect to get its marine engineers from the trimmer or fireman class is beyond my comprehension. Yet this Canada of ours enforces laws that a man who has served forty-eight months as fireman is eligible for passing the examination, or, as the law reads, "is entitled to a fourth-class engineer's certificate." When he reaches that grade he is called an engineer and can mount to the highest class without one day's training in an engineering establishment, only four years handling a shovel. We have them here often going about idle, for no engineer who knows them will trust such a one to pack a bilge pump, but they often succeed in obtaining work from people who do not know them, by producing this mighty document, an

Engineer's Certificate from the Great Dominion of Canada.

I do not know the regulations relating to the examination of engineers in the United States, but from the tone of many of the letters in last month's Marine Engineering I would conclude that you, too, back up the fireman class of marine engineers with all the majesty and authority of United States law.

My advice to young men seeking employment always is: Serve your apprenticeship of five years, make yourselves competent workmen, then come to me if you want to become marine engineers, but don't disgrace your profession by wanting to start as oilers. Oilers with us are good firemen, firemen are good trimmers promoted, but neither of them could ever become engineers on account of their being oilers or firemen, any more than they could become doctors or lawyers without going through the proper training.

Halifax, Canada. Old Salt.

QUERIES AND ANSWERS.

Q. 112.—Will you please inform me how to estimate the sizes of pump cylinders required to pump a certain number of gallons of water in a given time at varying elevations?

A.—Having given the number of gallons to be pumped in a given time, the volume per minute can be found by the following rule: Find the gallons per minute and multiply this by .1337, or, more shortly, by .134. The product will be the volume per minute in cubic feet.

To this must be added a certain amount to provide for the leakage past the plunger and past the valves. A pump plunger which displaces 1 cubic foot per stroke will not deliver that volume of water net. A certain amount will escape by leakage, and this must be provided for in estimating the plunger displacement. The amount of such leakage will depend on the condition of the pump, but should not exceed 10 per cent., though with the plunger and valves in bad mechanical condition it might rise considerably above these figures. An increase of from 10 to 20 per cent. should, however, cover this allowance in any ordinary case.

The next point to be settled is the number of strokes of the pump per minute, and whether the pump is to be single or double acting. These points settled, we then know the number of strokes per minute on which delivery of water is made. If the pump is single acting it will be the so-called number of double strokes or revolutions per minute. If the pump is double acting it will be twice this, or the number of single strokes per minute.

We then divide the total delivery per minute by the number of delivery strokes, and find the volume to be displaced by the plunger in one stroke. A suitable diameter and length of stroke can then be chosen to give this displaced volume.

The size of the cylinders thus found will be independent of the height to which the water is to be forced. The latter point will only affect possibly the slip of the pump or the percentage to be added to make up for leakage. It will affect the work done, but, aside from leakage, will not affect the necessary size of pump cylinder.

These operations may be illustrated by the following example:

Required, the size of pump cylinder for a double-acting pump making 40 double strokes per minute and to deliver 200 gallons per minute.

For the volume per minute we have $200 \times .134 = 26.8$ cubic feet. To this add 10 per cent. of itself, making $26.8 + 2.68 = 29.48$ cubic feet.

Since the pump is double acting and makes 40 double strokes per minute, there will be 80 delivery strokes per minute. The volume of one stroke will be, therefore, $29.48 \div 80 = .3685$ cubic feet $= .3685 \times 1728$ cubic inches $= 637$ cubic inches. We must now select a suitable diameter and length of stroke. This may require a few trials, but we shall soon find in this case, for example, that a cylinder 8 inches in diameter and 12 3-4-inch stroke will answer the requirement, or, if a shorter stroke is desired, it may be made 9 inches in diameter and 10 inches stroke.

If the pump is to be duplex, the size of each cylinder will be just one-half that required for a single pump for the same delivery.

Q. 113.—Please explain what is meant by the thermal H.P. or thermal pressure, as applied to a four-cylinder, triple, or other type marine engine. How is it figured? A. E. Z.

A.—The terms thermal horse power and thermal pressure must have been specially coined, as they are not in use in engineering. The thermal horse power might mean the I.H.P. divided by the thermal efficiency of the engine, or the horse power expressed in British thermal units—namely, 33,000 foot pounds divided by 778, the latter number representing the number of foot pounds equivalent to 1 B.T.U. Similarly, thermal pressure might mean the mean effective pressure divided by the efficiency.

Q. 115.—I intend using a 21-foot launch, and would like to know whether I would need to have the boilers for same inspected, and is it necessary to have a licensed engineer to run same? The engine is about 5 horse power. J. S.

A.—If the launch referred to is used for pleasure purposes only and is under 10 gross tons, it may be run by a special engineer; otherwise, a certified engineer will be required. In any case the boiler must be inspected.

Q. 116.—Will you please give one of your readers your views in regard to the following question: Is a propeller having two bronze blades and two iron blades opposite each other better balanced than a propeller having three bronze blades and one iron blade? The iron blades in each case are thicker and heavier than the bronze blades. G. E., Baltimore.

A.—The question of balance will depend entirely as to the location of the center of gravity of each blade and the weight of each blade. As the specific gravity of cast iron is about 7.1, and that of bronze about 8.3, the iron blades must be larger or heavier than the bronze ones. Assuming that the iron blade is of the same weight as the bronze, and its center of gravity is the same distance from the center of the shaft as the bronze blade, the propeller wheel will be balanced, whether one or two cast-iron blades be used.

Twenty-five-Knot Cunard Steamships.—The announcement of the Cunard Steamship Company that it will build two high-speed transatlantic steamships shows the intention of the British company to wrest the supremacy of the Atlantic from the Germans, who have held it for the past eight years. The dimensions of the vessels are stated to be about 750 feet long, 75 feet beam, with a horse power of 50,000. These figures, however, are only tentative. Although it is probable that quadruple-expansion reciprocating engines and twin screws will be adopted, this point has not been definitely settled.

Speed of Ship in Shallow Waters.—The chief of the North German Lloyd experimental station, Mr. J. Schütte, states that fast small craft like torpedo boats may run faster in shallow than in deep water, and that their trial runs in open water may be very misleading. His experiments with models demonstrate that boats whose length does not exceed 9.5 times the width, required in deep water an open channel of at least ten or twelve times their width. Regarding depth, the influence of the tank vanished for models of large steamers only when the available depth was 10.5 times the draft, and for the torpedo boats when the depth was sixteen times the draft. Thus trials of torpedo boats should be run in 160 feet of water to allow for increased draft due to sinking of the stern.

The United States Fleet in European Waters in 1872.

The advance in naval construction during the past thirty years is well indicated by a comparison of the fleet shown in the accompanying cut with a fleet of the present time.

On December 30, 1871, Rear Admiral James Alden, in his flagship, the *Wabash*, arrived at Villefranche, and on the 1st of January following relieved Rear Admiral Charles S. Boggs of the command of the United States naval forces on the European station. The vessels on the station during the next year and which formed the fleet of Admiral Alden were the *Wabash*, 45 guns; *Brooklyn*, 20 guns; *Congress*, 16 guns; *Plymouth*, 12 guns; *Shenandoah*, 11 guns; *Wachusett*, 6 guns—or, in all, 6 vessels and 110 guns.

These ships were all wooden and of the steam-frigate and sloop-of-war classes. The means of propulsion in all were by the screw propeller. The *Wabash* was a fine example of the old steam-frigate type, built in 1854 and of 4,650 tons displacement. The *Brooklyn* was built in 1857 and was somewhat smaller, having a displacement of 3,000 tons. The *Shenandoah*, 2,100 tons: *Wachusett*, 1,575 tons; and *Congress*, 3,050 tons, were built during the war, the latter in 1863 and the other two in 1861. The *Plymouth* was the newest of all, built in 1868 and of 2,400 tons displacement.

It is interesting to note that the combined displacement of these six ships is 16,775 tons, which is substantially the same as that of the new battleships *Connecticut* and *Louisiana*, now building, while of course the combined energy of gunfire would be insignificant as compared with that of a modern ship.

During the early part of the year the vessels of the fleet were kept together, with an occasional exception, and thus visited the principal ports of France, Portugal, and some of the ports of Germany, and the waters of England. Later in the year they returned to the Mediterranean, where separately they visited the various ports in southwestern Europe, the Levant, and the north and west coasts of Africa.

Admiral Alden's cruise extended from January 1, 1872, to June 2, 1873, when he was relieved and returned

Brooklyn. *Shenandoah.* *Wabash.* *Juniata.* *Wachusett.* *Plymouth.*

EUROPEAN SQUADRON, WABASH, FLAGSHIP, COMMANDED BY ADMIRAL ALDEN, 1872.

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home in the *Brooklyn,* where he arrived on the 10th of the following month. Throughout the cruise the usual exchange of courtesies took place between the admiral and his staff on the one hand and the officials and representatives of the ruling houses in the various European countries on the other, all of whom gave evidence of kindly feeling for the Government and people of the United States. While marked by no special incidents, the cruise of Admiral Alden has taken its place as one in which our flag was shown abroad with dignity and honor, and the old wooden ships of his fleet, now all but forgotten, well deserve a passing thought in this day of the modern steel fighting machine which has forever displaced the naval ideals of those days.

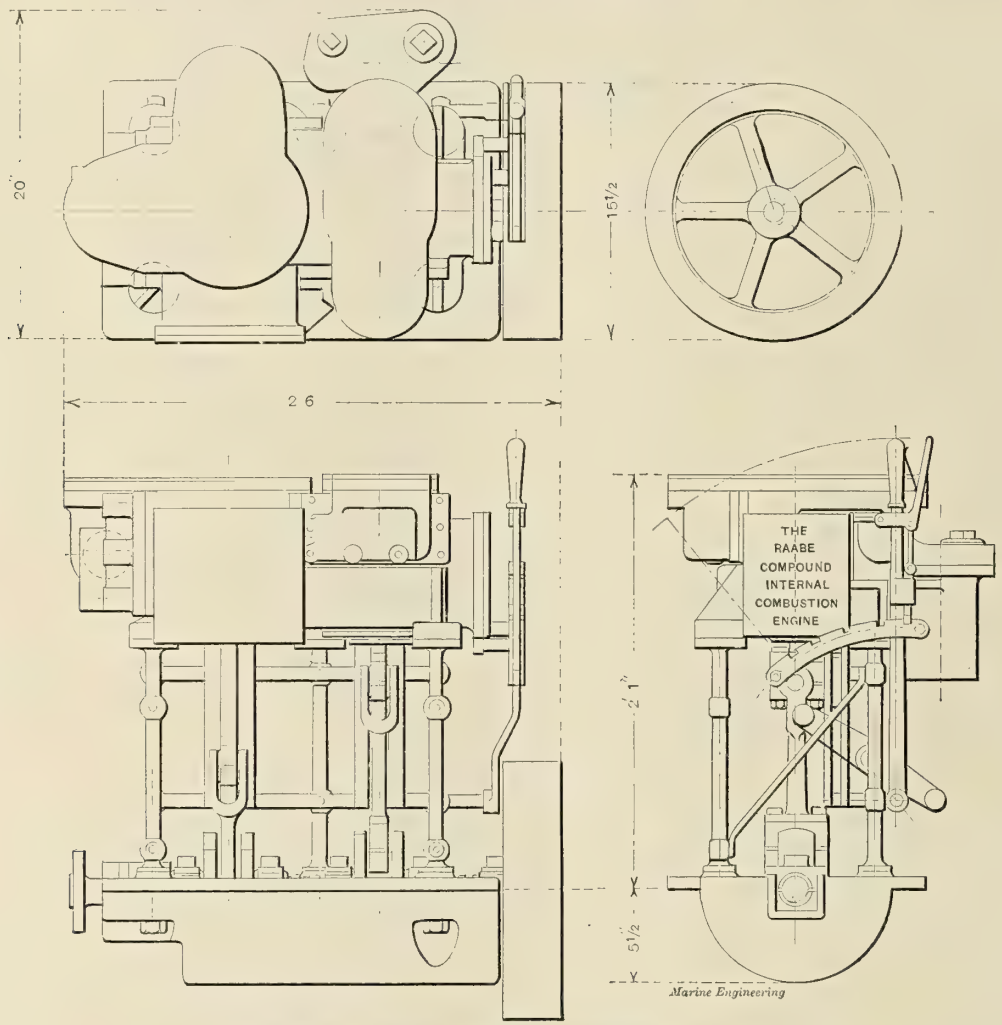
ENGINEERING SPECIALTIES.

Compound Internal-Combustion Engine.

The engines shown in the accompanying illustrations not only differ from other explosive engines, due to their great economy in floor space and weight, but also, being the first successful compound internal-combustion engines constructed, they also differ in cycle and their extremely high fuel economy.

The engraving on page 655 represents the 20-horse-power Raabe steeple compound marine-type engine, the weight of which is only 500 pounds, covering a total floor space of two square feet, with the following dimensions: Height from floor level to clearance line, 37 inches; length of bed plate, 17 1-2 inches; width of bed plate, 15 inches; length over all, including flywheel and coupling, 19 1-2 inches; width over all clearance, 18 inches; diameter of flywheel, 16 inches; weight of flywheel, 70 pounds; number of revolutions per minute, 600 to 800. In the line drawing is shown the fore-and-aft compound marine-type engine of 20 horse power, with a weight of 500 pounds, covering a total floor space of 3 square feet. The dimensions are as follows: Height from floor level, 28 inches; length of bed plate, 24 inches; width of bed plate, 15 inches; length over all, 30 inches; width over all, 21 inches; diameter of flywheel, 15 inches; weight of flywheel, 65 pounds; number of revolutions per minute, 800 to 1,000.

The fuel used in these engines is ordinary kerosene oil, but, if preferred, gasoline or common illuminating gas may be used without making any changes to the engine. The mechanical reversing gears, which are so well known to the owners of launches, are entirely abandoned, as the whole engine reverses with a positive reversing gear—*i. e.*, if the go-ahead gear is thrown into action by means of the reversing lever shown in the cuts, it will be impossible to run the engine in the opposite direction; the same holds true about the go-astern gear. By throwing the lever into the midway position the engine is stopped, and any intermediate position regulates it for slower speeds.

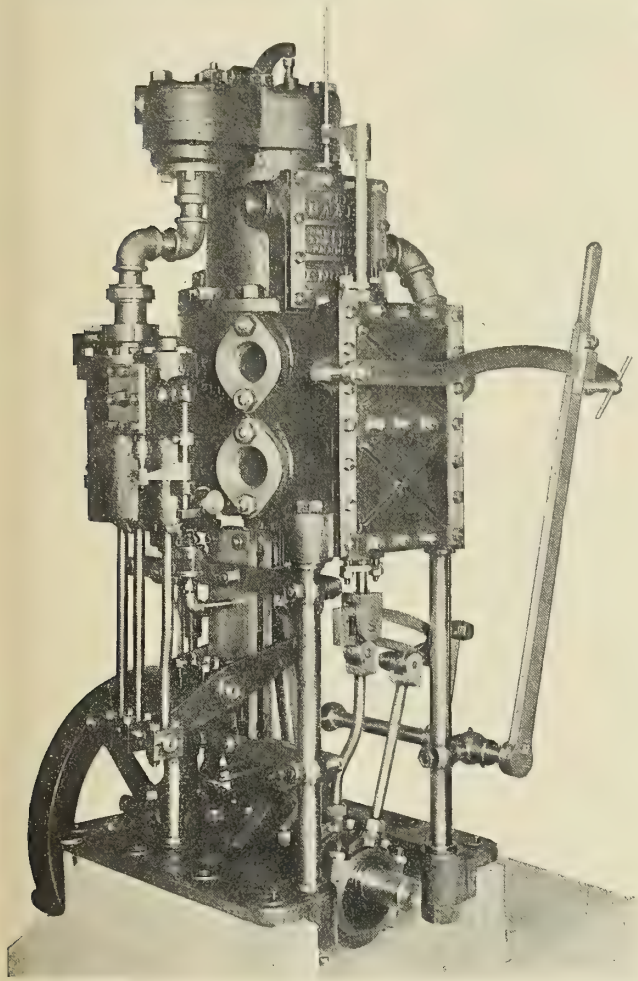


FORE-AND-AFT COMPOUND INTERNAL-COMBUSTION ENGINE.

These engines can be built from 20 horse power up to several thousand horse power. For engines of 60 horse power and above no flywheel is provided, as the engine can be started without necessitating the turning over by hand. All bearing surfaces are made extra large, avoiding all possibility of overheating at high speeds, even with moderate lubrication. The engines are especially well suited for direct-connected units for isolated electric lighting. Being double acting, the rotary

motion is very regular, unlike the engines of the two- and four-cycle type. The exhaust is absolutely noiseless without the use of a muffler, owing to the fact that the gases are expanded down to atmospheric pressure.

These engines are built by the M. and R. Engineering Company, 202 West 103d street, New York, builders of the two and four-cycle types of gas engines for marine, industrial, and automobile use.

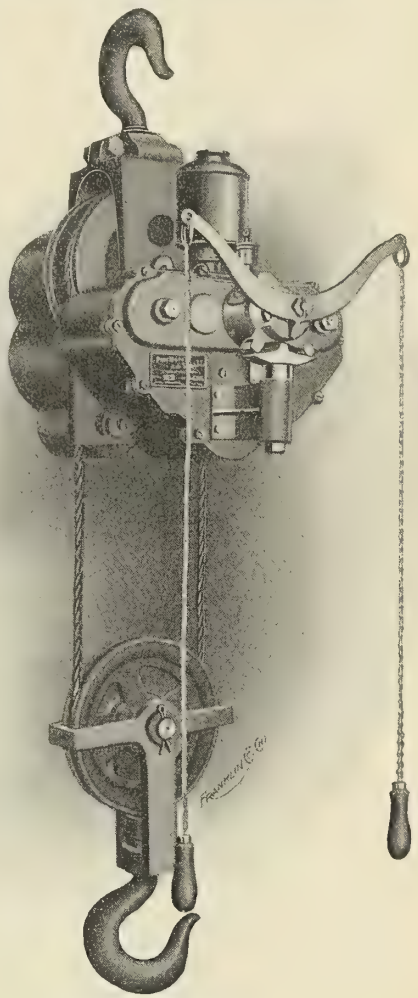


STEEPLE INTERNAL-COMBUSTION COMPOUND ENGINE.

A Pneumatic Hoist.

The value of compressed-air apparatus, such as hoists, drills, and cranes, depends almost entirely upon the quality and economy of the motors. The machine here illustrated is the Port Huron pneumatic motor hoist. The engine consists of two oscillating double-acting cylinders set at right angles in an air-tight case. There is no movable valve mechanism, as the oscillation of the cylinders opens and closes the ports and gives clean cut-off. The cylinders oscillate from the extreme end and there are eight ports for each. When the engine is on dead center the air is all shut off, and when she starts the feed and exhaust ports start to open, and when on half stroke the ports are wide open, gradually closing until dead center is reached. A small quantity of oil is kept in the case, so that the crank revolving lubricates itself and dashes the oil to the valve seats.

The motor handles the load of the hoist through straight line gearing, and is controlled from the crane by two chains. The motor may be instantly started, stopped, or reversed, and is operated by a three-way valve, which is kept tight by a stuffing box. The valve is self-closing when the chains which operate it are released. A wire rope is used on the winding drum, as it runs smoothly and raises the load without jar, which is the case when a chain is used. The ball bearings are bushed with phosphor bronze and the gears are of cut steel, and all parts are made interchangeable.



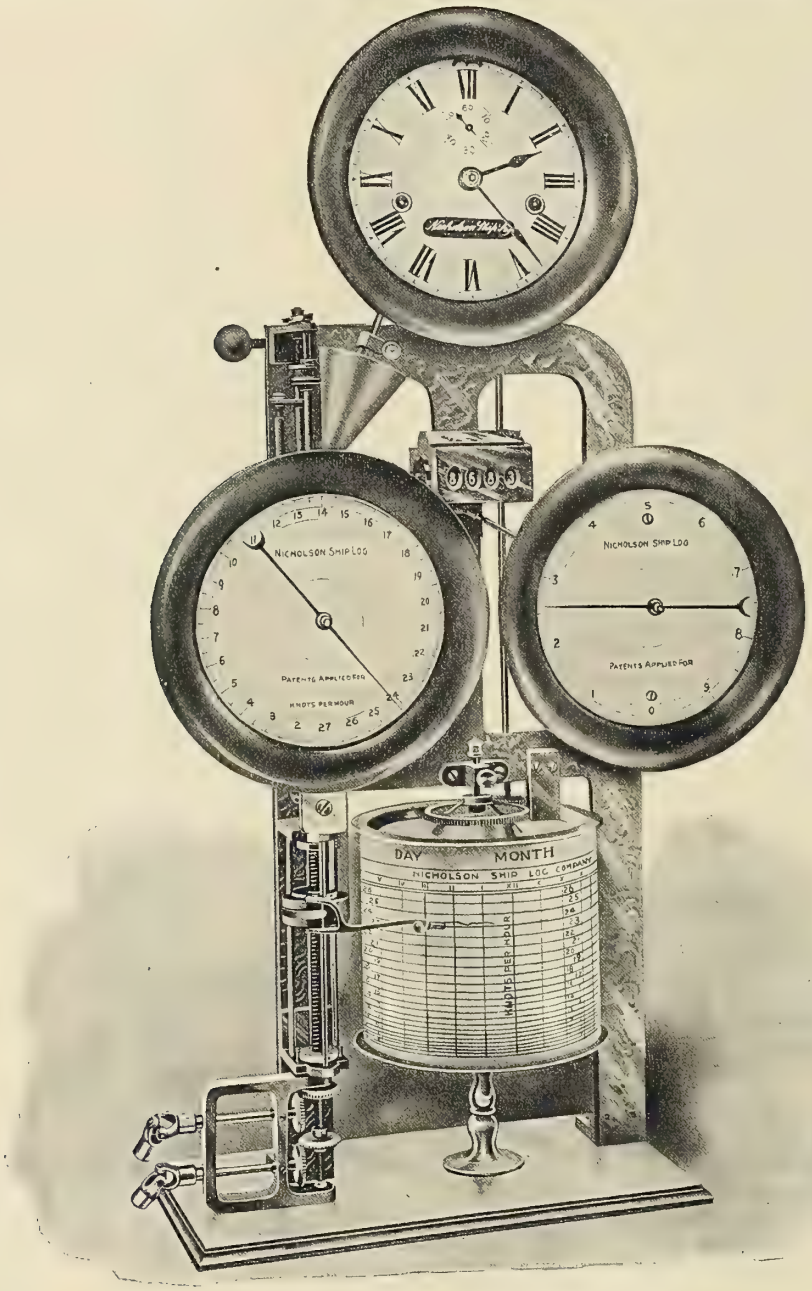
PNEUMATIC MOTOR HOIST.

A four-chain hoist running all day will not consume the air that an ordinary chipping hammer will require, for the reason that no matter how much material is handled with the hoist the latter is actually working but a small percentage of the time. The hoist is made in sizes from one to ten tons capacity, and many of them are now in use. For further particulars address the Port Huron Air Tool Company, Port Huron, Mich.

The Perfected Ship Log.

In the Nicholson ship log is found a mechanism which reliably and accurately records the speed of a vessel and which is not influenced by conditions of weather. No floating log is required, as the mechanism is all contained within the ship itself. The principle of the device is the variation in the height of a column of water, the

lower end of which, extending through the bottom of the vessel, is exposed to the pressure of the outside water due to the speed of the ship. A float in this column of water indicates the speed. This briefly is the principle, but in carrying it out intricate problems had to be dealt with. One of these was to compensate for the level of the water in this tube due to different draft of the vessel, intake pipes, which are 1 inch diameter. Pipe B, which we will call the recording pipe, is closed at the bottom, but has a small hole on the forward side. Pipe A does not extend outside the line of the hull. The upper ends of these two pipes are connected to two 3-inch stand pipes, and as the speed of the ship increases the water level in pipe B rises. The water level of



RECORDING DIALS OF THE NICHOLSON SHIP LOG.

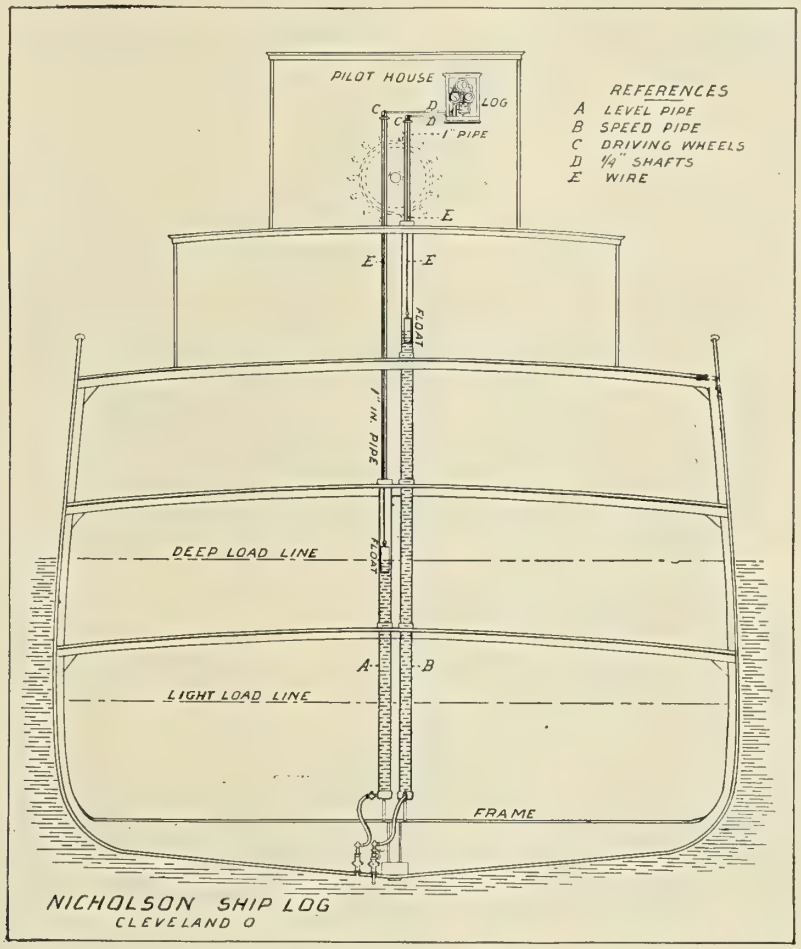
light or loaded. This is accomplished by placing a second tube opening to the outside water at the bottom of the vessel, but not subjected to any forward pressure. Thus the speed of the ship is measured by the difference in level of the two columns, the latter column being called the draft regulator. Two seacocks are placed on the bottom of the vessel, preferably near the center line, and fitted with stuffing boxes through which are run the pipe A, however, depends only upon the draft of the vessel. Floats are placed in each pipe and the two cords are led to the tops of the pipes, wrapped around two wheels, and kept tight by counterweights. The shafts of these wheels are connected through universal joints to the actuating device shown at the lower left-hand corner of the above cut. These two motions drive a compensating screw with ball bearings, so that when

both shafts are turned the same number of turns there is no change of the recording levers. This happens when the vessel is in dock being loaded or when pitching or rolling at sea.

Turning now to the recording device, it will be seen in the cut that above all is a clock. To the left is a dial indicating the speed; in the middle is a counter which adds up the number of miles traveled; to the left is a speed indicator showing the fractions of a mile, and at the bottom is a revolving cylinder on which a record is made of the speed during twenty-four hours. The three latter dials are operated by the clock.

It was found by experiment that the height of the water in tube B varied as the square of the speed; therefore it was necessary to have specially-constructed gearing for the speed indicator, so that each mile could be shown by the same increment of space on the dial. It will be noted that this gearing is above the drum recorder, and upon the latter the vertical distances which represent the speeds are laid off according to the squares of the numbers. The compensating nut carries an arm which draws the curve of speed and to this nut is attached a vertical lever driving the gears above mentioned. These gears operate the speed dial and also through a rack and pinion move the point of contact up and down the speed cone, shown at the upper left-hand side, which is driven by the clock. This friction will actuate the counter, and the indicator at the right hand.

It will thus be seen that all the necessary indications and records of a ship's speed are obtained, and in practice it has been found that the mechanism works with extreme accuracy. Indeed, slight variations in speed, caused by turning of the rudder, are clearly shown and a speed curve is secured of such refinement as never before known. This log has been placed on several Lake steamers and is now being installed on the Coast. It is made in several forms, the simplest of which is the speed indicator alone. Further particulars can be had by addressing the Nicholson Ship Log Company, Cleveland, Ohio.

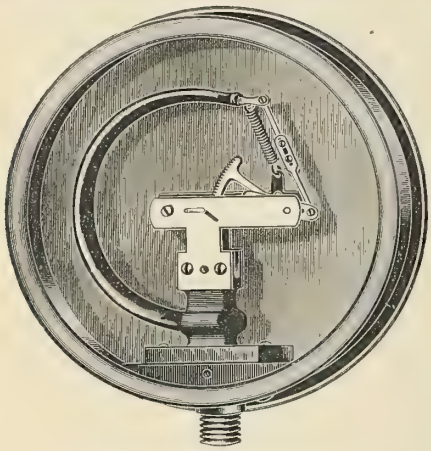


ARRANGEMENT OF PIPES FOR RECORDING SHIP LOG.

Pressure and Vacuum Gages.

These gages are of the well-known Bourdon spring type, with springs of solid drawn tube. This principle is acknowledged as the best for commercial purposes for indicating pressure. A so-called angular independent or suspended movement is employed on all these gages. The original type of movement made first in 1853 is necessarily fastened to the back of the gage case. This is a defect acknowledged by all who are versed in the manufacture of gages, as it has many objectionable features: First, in screwing the gage to pipe connection it strains the movement and often throws the rod

connecting the free end of the tube with the segment out of line, and no gage can be correct after this has occurred. Second, the unequal expansion and contrac-

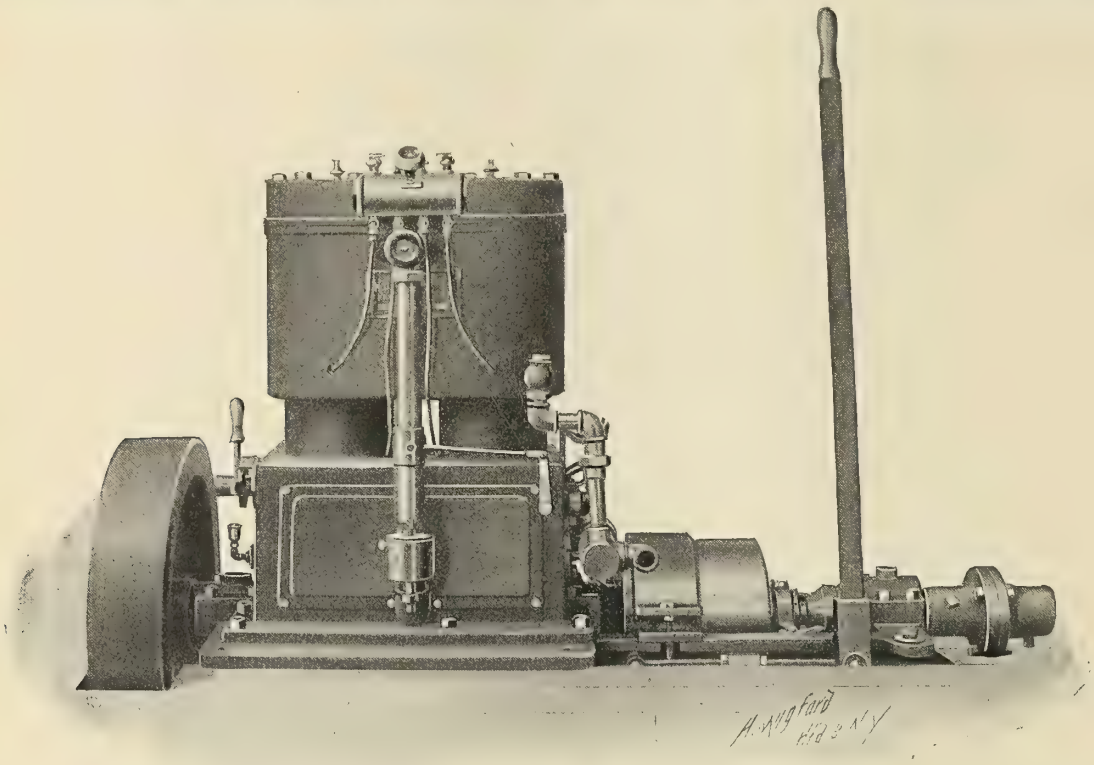


PRESSURE AND VACUUM GAGE.

tion of the metal case and movement is a serious defect when the latter is held in position by being screwed to the back of the case; the old types of movement expand more or less, particularly when exposed to heat, which is the case in many instances, and this means a false indication, and it is not long before the gage becomes seriously defective and unreliable. The construction of the independent or suspended movement is such that it provides a free air space, and comes in contact with the case at one point only, namely, at bottom or side, and not at two points as in the old construction. Movement plates and segments are made from a special composition, after particular attention has been given to its wearing qualities. Pinions and arbors are made from either German silver or "silver metal," both being strictly non-corrosive. The last-named metal is highly recommended for this purpose, inasmuch as it has tensile strength and wearing qualities equal to, if not greater than, steel. Attention is also called to two new lists in gage prices, namely, aluminum and "silver metal" cases; the advantage of the former will be readily seen from the fact of its extreme lightness. Silver metal cases are recommended where a very rich and superb finish is desired. It takes the place of nickel plating, with the advantage that it will never wear off or tarnish and is not affected by acids or ammonia. These gages are all graduated from an open mercury column U. S. Government Standard 14.7 pounds to the atmosphere and warranted correct. Dials may be furnished in white enamel, silver, or black finish. Further information may be obtained from the Standard Gage Manufacturing Company, of Syracuse, N. Y.

New Marine Gasoline Engine.

The Mianus Motor Works, Mianus, Conn., has placed on the market a new 12-horse-power four-cycle gasoline engine of the marine type. This engine is made from new patterns and designs, and is remarkable for its simplicity and neatness of design. The particular points of excellence are the easy starting device, the largest size motors being started with a lever without touching the flywheel or cranking; the ignition is adjustable with a hand lever, so that any lead may be obtained instantly; oiling is accomplished by a reservoir system of lubrication which is similar



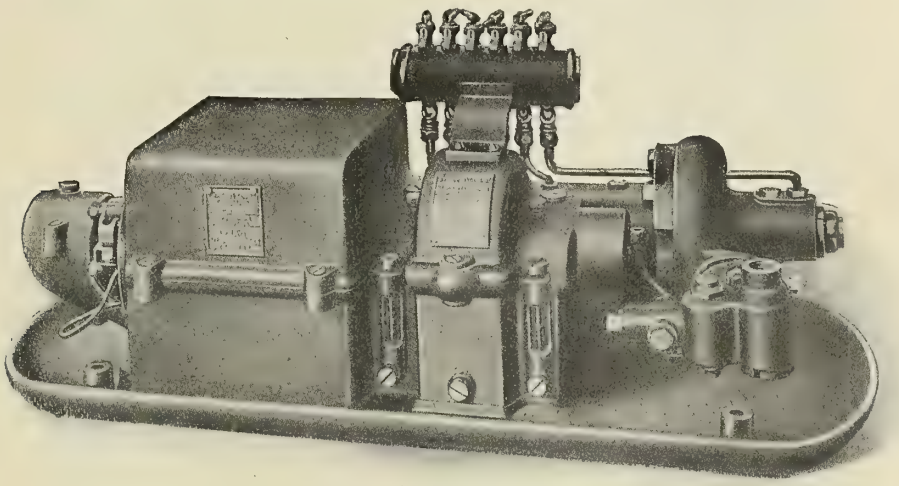
NEW TYPE MARINE GASOLINE ENGINE.

to the best practice in steam engines; the admission of gas is controlled by a throttle valve, so that any speed may be obtained; and reversing is accomplished by a strong reversing gear constructed to carry double the load necessary.

Searchlight Generating Set.

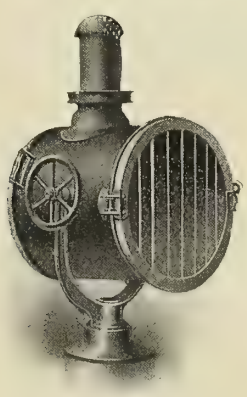
The advantages of the searchlight for use on harbor and river craft and pleasure yachts is already generally recognized, but the size of the generating set prevents in many cases its adoption.

Where electric lighting is used on small vessels the generator will be too small for running an arc light in addition to the incandescent lamps, or, if the generator is large enough for supplying current to both, it is too large to run economically when operating only the incandescent lights.



TURBINE-DRIVEN GENERATING SET FOR SEARCHLIGHT.

The little De Laval generating set here illustrated is built specially for this class of work and embodies features entirely new in this class of machinery. In



IMPROVED SEARCHLIGHT.

place of the ordinary reciprocating engine a De Laval steam turbine is used, which in the cut is seen placed at the right hand. Steam enters through a governor into one nozzle and drives the turbine at a speed of 45,000 revolutions per minute. The generator shaft, geared down 10 to 1, turns 4,500 revolutions per minute. Oiling is entirely automatic through pipes from the oil cup on top, no cylinder oil being required.

The generator, made by the General Incandescent Company, can be wound for either high or low voltage. On a test of one of these little machines 1 1-2 brake horse power is claimed to have been developed on 50 pounds steam per brake horse power, which is a very great saving over other turbines of this small size. The searchlight is built especially for very hard service and the lamp is constructed to withstand any amount of shaking and vibration, no clamps or outside levers are used, and the carbons will burn without renewing for forty-eight hours. The feeding device is governed by a solenoid. A Mangam mirror reflects the beam, so that boats may be detected for over a mile distance. The focus may be adjusted by a thumbscrew at the top of the lamp. This outfit is entirely complete in itself, and all that is necessary is to make the steam connection and connect the terminals of the dynamo with the lamp. The set may be placed in any convenient or out-of-the-way corner. The oil pan at the bottom is but 27 inches long and 11 inches broad, and the total height is 11 inches.

Further particulars may be had by addressing the New York Electric Headlight and Train-Lighting Company, agents of the De Laval Company, 52 Broadway, New York city.

Taylor Water-Tube Boiler.

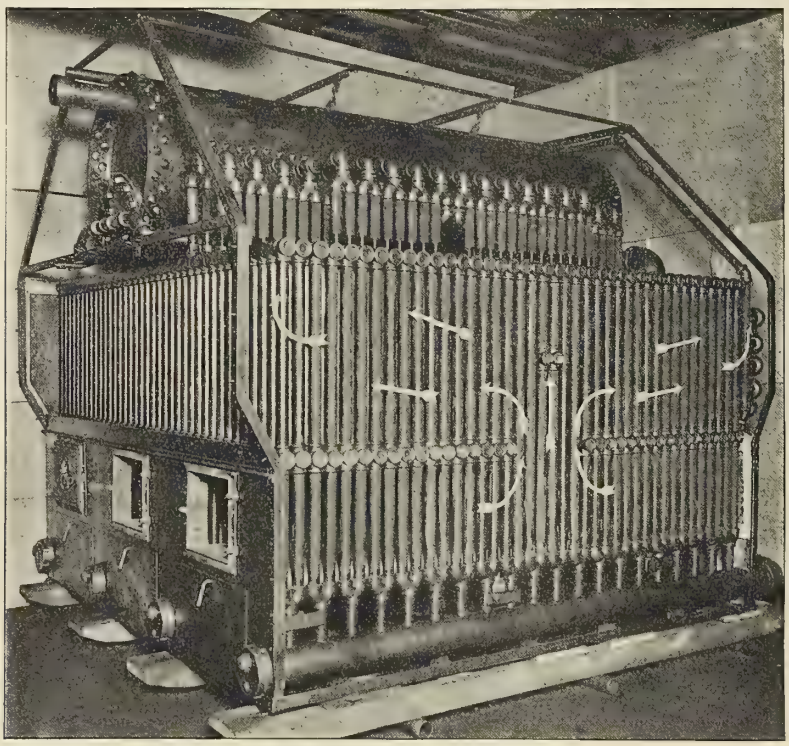
The Taylor water-tube boiler here illustrated is radically different from the usual type of marine boilers, both in the way the furnace gases are handled and in its extremely short circulation. The advantages claimed for this boiler are a well-designed firebox, good combustion chamber, long and definite course for the furnace gases, and one in which the water tubes are so arranged that the steam finds ready access to the drum without displacing the water in the tubes.

The boiler differs much in construction from others which have screwed connections, as all the generating tubes are vertical, except the horizontal headers above

the grates and above the combustion chamber. It is termed a sectional boiler, as it is built up of sections of tubes rather than separate tubes, and this is made the claim for ease of repair.

In general the boiler consists of a large number of short straight vertical water tubes over the fire, connected with headers, which in turn are connected with manifolds at the bottom and a steam and water drum extending lengthwise of the boiler at the top. As shown in the accompanying engraving, there are four large bottom manifolds reaching from front to rear of the boiler at some distance below the grate. From these, two or four down-flow pipes arise outside the casing and connect with the drum below the water line. Connection is also made with the bottom manifolds by vertical pipes spaced widely apart, which at the grate level are screwed into branch connections, from which the pipes are then carried up in pairs and connected with tees and four-way fittings with the nests of generating tubes, which occupy the space all above the combustion chamber and below the drum and form the principal heating surface of the boiler. These rows of tubes, rising from the bottom manifolds and extending from back to front of the boiler, divide the furnace into three grates, for each of which a door is provided in the casing. The tubes composing the generating system are in short lengths and are fastened together by nipples which are screwed into the end connections, the latter being faced and butted up tightly, so as to protect the threads from the action of the fire, and forming top and bottom headers. Between the drum and the casing on each side—one tube for each section—two rows of tubes extend upward from the generating nests and connect by bends with the drum. The connections at the lower ends of the generating tubes are arranged to form the crown sheet in such a way as to compel the gases to travel in the course indicated by the arrows in the drawing, which is somewhat the same in general direction as in the cylindrical double-end marine boiler. At each end of the section manifolds or headers a plug is fitted, which on removal permits of examination and cleaning of these manifolds.

In the steam-generating tubes the circulation is not all in one direction; in some the flow is upward and in others downward, the pipes above the nests of tubes, with outlets into the drum, carrying up comparatively little water to the drum. Inside the drum there is fitted a dry pipe and separator, connecting on the outside with the boiler stop valve, and it is claimed by the manufacturers that their boiler is notable for furnishing dry steam. This boiler has been installed on several yachts and other vessels. The builder is the Taylor Water-Tube Boiler Company, 345 Franklin street, Detroit, Mich.



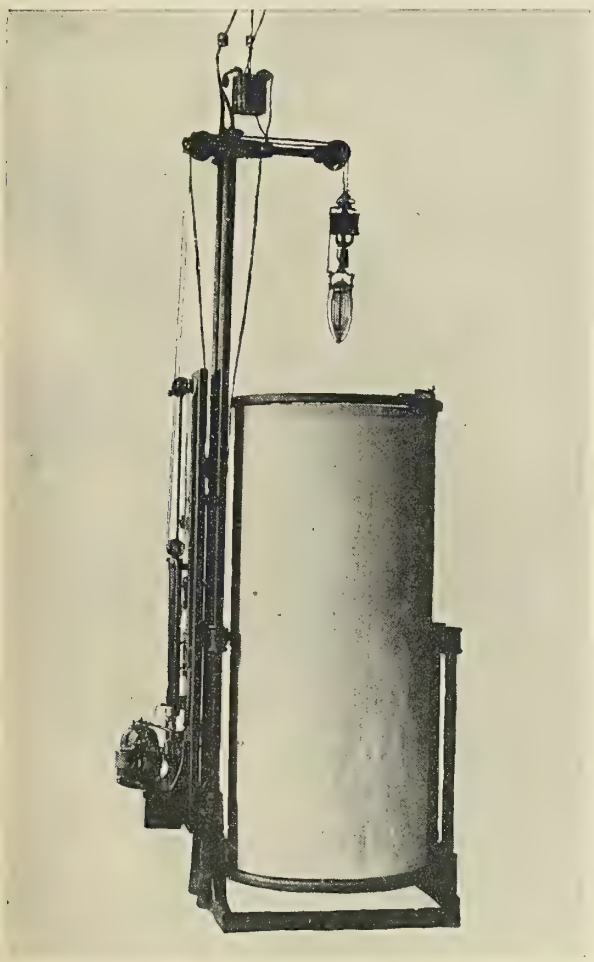
WATER-TUBE BOILER OF THE STRAIGHT-TUBE TYPE.

Electric Blue-Print Machine.

Those having to make blue prints realize the loss of time and money incurred by relying upon the sun's rays for exposures of the sensitive paper. The electrical blue-printing machine is now well established, as this may work on cloudy as well as sunny days, when the operation of blue printing may be carried on wherever the machine may be erected. The apparatus here illustrated consists of a cylindrical printing frame, composed of two heavy curved plates of glass bedded in soft material in an adjustable though rigid frame, together with two tubular uprights which support the arc lamp and automatic drive mechanism. This drive operates the lamp, having means for lowering it through

the cylinder and then automatically raising it again to its former position. The cylindrical frame revolves on trunnions, so that it can be swung to a horizontal position, which is the most convenient method for inserting or removing tracings and paper from the frame.

In operating, the cylinder is revolved to a horizontal position and the tracing and sensitized paper are placed around the outside of the cylinder, being confined by stout canvas covers, which are drawn tight by turning a lever, thus insuring perfect contact between tracings, sensitized paper, and the glass. The cylinder is then swung to the opposite horizontal position and the same



MACHINE FOR BLUE PRINTING BY ELECTRIC LIGHT.

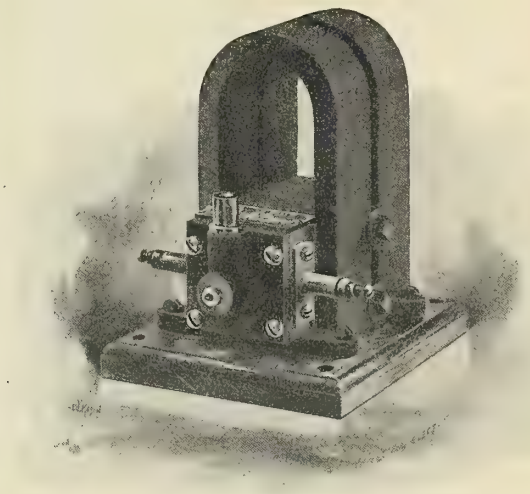
manipulation repeated, after which it is returned and locked in vertical position and is ready for printing. By simply touching a lever the arc lamp starts in its descent through the center of the cylinder at a speed which can be regulated to suit the sensitiveness of paper employed. When the lamp has reached the lowest point of printing surface, it automatically reverses its motion and quickly returns to its original position above the cylinder.

These machines are entirely self-contained, no brackets or pulleys on the walls or ceilings being required. Further particulars may be had by addressing the manufacturer, the Eugene Dietzgen Company, 119 West Twenty-third street, New York city.

Direct-Current Magneto.

Although the magneto used in connection with the ordinary spark coil for gas-engine ignition is a small machine, its proper design and construction require much care, for the machine must run under the most disadvantageous conditions and must run at all times.

The magneto here illustrated is made by the Remy Electric Company, of Anderson, Ind., and was designed especially for use in connection with launch and automobile engines. The magneto is mounted either on a solid base, as shown in the illustration, or with a shifting base when a friction drive is used. The magnetos used in this M.V. type are made from the best American magnet steel, which has the highest magnetic density to insure permanent retention of magnetism. The armature is of the iron-clad, laminated-core, drum type, wound with double steel-covered magnet wire. The lead wires from the coil to the commutator are encased in sleeves, after which they are bound down, shellacked, and baked, making the armature similar to that of high-voltage machines. The commutator is much larger than usual in proportion to the size of the machine and is arranged on a steel core and insulated throughout with mica. In low-voltage machines special attention must be given the selection of a brush, so that the commutator will not be cut. The brushes used are of specially low-resistance carbon.

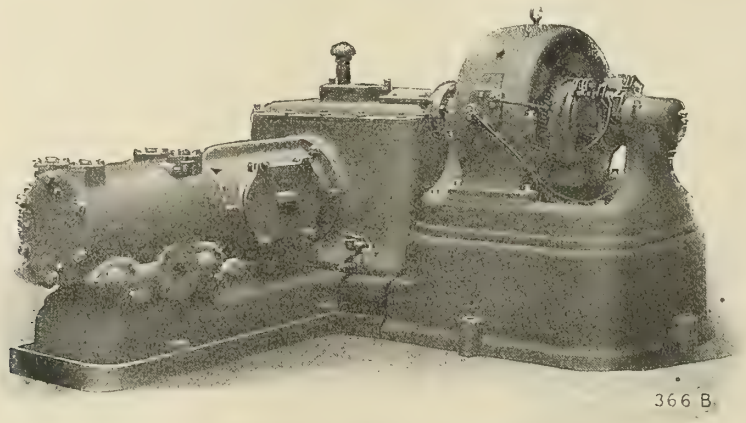


DIRECT-CURRENT MAGNETO SPARKING DEVICE.

Motor-Driven Air Compressors.

Compressed air, which is daily coming into greater use in marine work, is a recognized indispensable agent, and the apparatus which is the simplest and most efficient is, of course, the most desirable. The N. A. Christensen air compressors, made at Milwaukee, Wis., are built specially for small work for both portable and stationary use. The type M motor-driven compressor here illustrated is of the latter class and built in capacities from 50 to 1,000 cubic feet of free air per minute. As will be seen, the electric motor and compressor have been designed to form a compact, self-contained unit. The air is compressed in the cylinders shown at the left. The entire machine is mounted on a substantial cast-

iron base. The cylinder and valve heads are water-jacketed, and clearance spaces are reduced to the lowest practicable limit. The suction and discharge valves, which are interchangeable and of seamless cold-drawn steel, are mounted in cast-iron heads and each is removable independently of the other. No springs are used to seat the valves, they being operated by compressed air and gravity. The piston is provided with improved form of packing rings. The piston rod is of steel and passes through a self-adjusting metallic packing box. The connecting rod is also of steel. The crosshead is fitted with adjustable shoes of large area and with a hardened tool-steel wrist pin, accurately ground and bearing in phosphor bronze boxes on the rod. The crank shaft, of high-grade steel, is extended at the motor end to carry the gear, which is driven by a pinion on the armature shaft of the motor. The gear and pinion are of the helical herringbone type. The gear case and crank chamber are connected, forming an enclosure which is partly filled with oil by the revolutions of the crank. All lubrication is secured by the oil in this chamber.

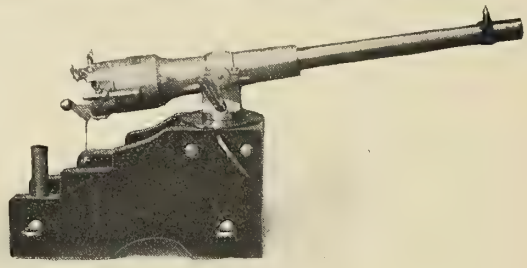


A MOTOR-DRIVEN AIR COMPRESSOR.

Either an alternating or a continuous-current motor may be used, the illustration herewith showing one of a continuous-current, multipolar type. As much care has been given to the design of the motor as to any other part of the machine, and throughout the design of the unit is such that every part is easily and quickly accessible. An automatic governor starts and stops the motor compressor at the desired minimum and maximum pressures. This consists of an ordinary pressure clutch mechanism with a special hand, which, upon coming in contact with a connecting stud at the position of minimum pressure, allows the current to flow through a magnet coil. This coil operates a plunger to which the contact pieces over the motor circuit are attached, thereby closing the circuit and starting the motor. When the pressure reaches the desired maximum this hand strikes another stud and the current passes through a second solenoid magnet, thereby pulling the plunger in the opposite direction and opening the motor circuit. Various types of motors are made by this company for stationary and portable uses.

Signal Gun.

A good gun is a necessity to every well-ordered yacht, yacht club, or steamship. Naval architects and designers generally will welcome any improvements on the clumsy and antiquated style of gun heretofore in



A NEW SIGNAL GUN.

use. The cannon shown in the accompanying illustration is a new type, similar and embodying the good points of modern naval ordnance. This style of deck carriage mount is of mahogany and polished bronze, with ball-bearing rollers—a commendable feature, permitting of movement in any direction, as, with the regular high, conical, bronze deck stands with which these cannon are ordinarily supplied, this gun can be elevated and depressed and pointed in any direction, the carriage remaining stationary. The gun and carriage are separate for convenience in stowing.

A large variety of sizes appropriate for sailing vessels are supplied by the makers, the Naval Electric Company, 95 Liberty street, New York city.

Japanese-Built American Gunboat.—The first of an order of five gunboats for service in the Philippine Islands and built in Japan was launched on October 16. The vessel was christened the *Remblon*.

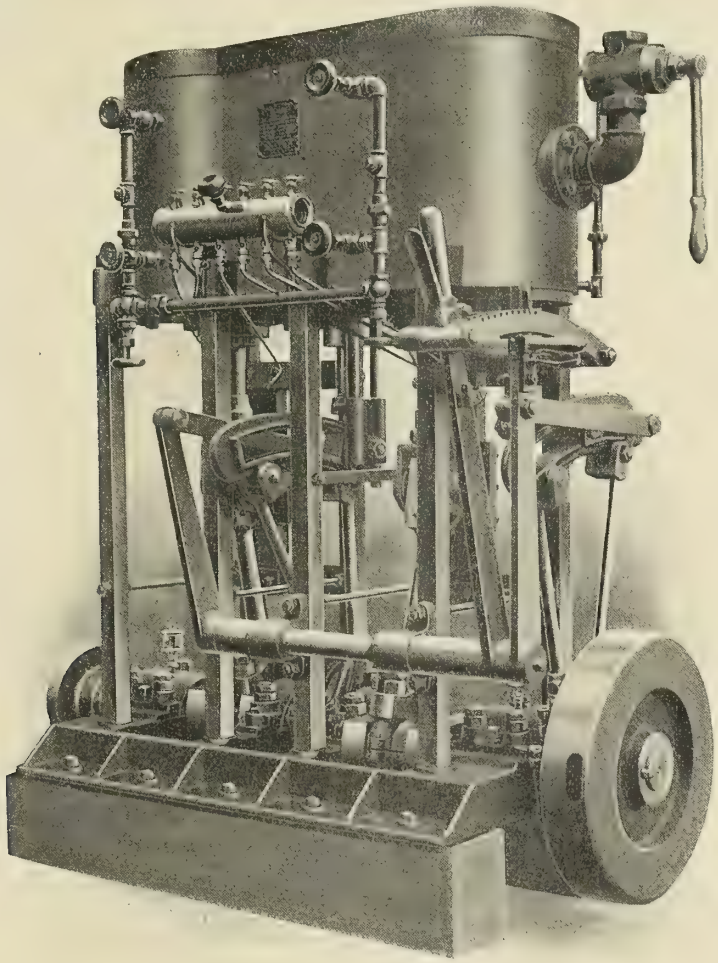
Steam Turbine.—Mr. John Jacob Astor has advised the public through the *Scientific American* that he relinquishes all claims to his patents on his steam turbine which recently were granted him. He hopes that this act will result in the advancement of the steam turbine for marine and other purposes.

The Reeves Compound Marine Engine.

In the accompanying illustration will be seen a view of the Reeves standard marine compound engine, made by the Reeves Engine Company, Trenton, N. J., which embodies several novel features. One of these is the elimination of the receiver from the cylinders, whereby most economical results are claimed. The materials used throughout are of the very best, cylinders being made in one casting of very close grain charcoal iron. Counterbalances are placed on the crank webs and the shaft is made from one forging, of open-hearth steel. The pistons are of cast iron, well ribbed and braced, and the rods are carefully turned from high-grade steel and ground to size. They are fitted to the piston heads on tapers and secured by lock nuts, and are fastened to the crossheads by long threads and held by jam nuts. The crossheads are of the box pattern, with ample wearing surfaces, which are faced with anti-friction metal. Connecting rods are of forged steel, the upper end being solid and fitted with bronze boxes; the crank ends are made of steel castings lined with babbitt metal. Means are provided for correctly adjusting wearing surfaces.

The valves used in these engines are of the Reeves patented adjustable type, working in seats having milled ports. Either end of these valves can be adjusted without removing the valve from the seat, by simply removing the bonnet, which permits the adjustment to be made in a very few moments. In a later issue we shall describe this valve in detail.

Another simple but efficient device is applied to the reversing gear, whereby the cut-off in the high-pressure cylinder may be regulated according to the needs of the work and still permit the low-pressure to be run at a fixed cut-off, thus maintaining the same economy as where a governor is used.



COMPOUND MARINE ENGINE.

This is accomplished by having the reversing arm operating the links of the high-pressure cylinder loose upon the reversing shaft and so that it may be set at any point of cut-off. The main lever, which is connected to the low-pressure gear, automatically picks up and carries the cut-off lever of the high pressure with it, wherever the latter may be set when the engine is thrown over from either direction. These levers remain securely locked together until the admission valve is wanted for cut-off purposes.

TECHNICAL PUBLICATIONS.

Mackrow's Naval Architect's Pocket Book. By Clement Mackrow. Size, 4 by 6 1-2 inches; pp. 750, with numerous cuts and diagrams. D. Van Nostrand Company, New York. Price $5.

The practical architect and engineer demands every possible aid which may serve to shorten the routine computations which he is required to carry out. To this end, slide rules, planimeters, tabular information of every character, and handbooks filled with formulæ, convenient tables, and other aids—these all form a necessary feature of the modern office outfit. Perhaps foremost in importance among these is the pocket book of formulæ and useful information. No one can be expected to remember the manifold formulæ and methods relating to the various problems with which he is called upon to deal. The original literature relating to these various operations is scattered through a dozen sets of engineering transactions and other technical publications, and the purpose of the handbook is to avoid the necessity of too frequent reference to these original sources. It is intended to be the digested product of a library of technical literature. In the field of marine construction Mackrow's pocket book has come to fill this requirement in a very satisfactory manner. Where the field to be covered is so vast, the selection and arrangement of the matter will naturally depend much upon the individuality of the compiler and upon his judgment regarding the information most likely to be of practical use. The present is the eighth edition of this work, so well known as to require no detailed description. Comparing it with earlier editions, we find evidence of revision and of some considerable increase in the amount of matter; in all, some fifty pages have been added. The intention has been to bring the matter down to date and make it representative of the present condition of science in marine construction. The subjects dealt with are grouped systematically under distinct headings, so as to facilitate reference apart from the index, and, as in recent editions, the various tables are placed together at the end of the volume. In the successive revisions of this work special attention has been given to the general subject of the strength of vessels and to the elementary problems relating to the strength of materials, bending moments, shearing stresses, etc., with special regard to their application to such problems. In some respects the revision might, perhaps, have been more thorough, and data and information relating to ships having now only historical interest might have been omitted or replaced by information relating to the modern fleet. Thus on pages 133 and 134 are found a series of particulars, including coefficients of performance, relating to English naval ships dating back as far as the sixties of the last century. Most of these have small interest for the modern designer, and their place might have been acceptably taken by more modern information. In several other places of the book similar out-of-date information is to be found. Taken as a whole, however, the compilation generally shows good judgment, and the compiler has succeeded in bringing together a vast amount of useful information in a form convenient for use in a drawing office, without reference to original authorities. As with all books of this type, it must be used with judgment. It does not pretend to give demonstrations or reasons; it gives simply methods and information. These must be applied with discriminating judgment. Under this limitation the field of usefulness for such books is great, and we can recommend this as a mine of useful information to all who are engaged in this field of engineering practice.

Lucas' Questions and Answers for Marine Engineers, with Chapter on Breakdowns at Sea. By Theodore Lucas. Size 5 by 7 1-2 inches, pp. 507, with 188 figures in the text and twelve folding plates. New York, Theodore Audel and Company. Price $2.00.

The catechism form of text book for self-study has proved its usefulness so thoroughly that it has come to be one of the standard forms of aid for those who wish to prepare in this manner for advancement in the ranks of the operative engineer. Most of the text books available for such study have been hitherto of English publication, and therefore in some respects not directly adapted to the uses of engineers in the United States. This lack has been made good by the publication of the present book, the purpose of which is to help in this manner the engineer who is trying to help himself. The work as a whole is divided into two main parts relating to construction and operation. Otherwise, in relation to subject matter, the book is divided into nine parts and twenty-seven chapters, giving convenient headings and sub-divisions for the various items to be considered.

Part one takes up fundamental principles, combustion and fuel, steam and its properties, mechanics and the economics of the marine engine. Part two takes up in detail the steam boiler and steam generation; part three, the marine steam engine; part four, paddle wheels and propellers; part five, auxiliaries; part six, piping; part seven, care and operation of marine machinery; part eight, breakdowns and repairs; part nine, materials and strength.

The treatment of the subject is simple, instructive, and generally clear. Occasionally the necessary brevity interferes with the fuller treatment which the author would doubtless have been glad to give had the limits of space permitted. The illustrations as a rule are excellent, and the presswork and binding are in the standard style of the publishers. The book should prove of value to all who are desirous of obtaining brief and simple explanations on most of the topics which concern the marine engineer, in connection with the construction and operation of the machinery which is placed in his care.

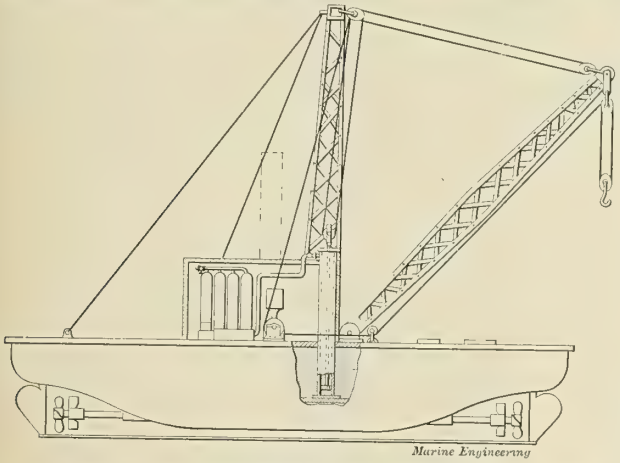
Machine Shop Arithmetic. By Fred H. Colvin and Walter Lee Cheney. Size 4 by 6 inches, pp. 131. Price 50 cents. New York: The Derry-Collard Co.

This little book is intended as a convenient pocket companion to the mechanic and to provide him with simple discussions of many of the every-day shop problems which arise, and to provide accurate and rapid methods for their solution. Instead of furnishing a bare rule, the purpose of the authors has been to furnish, as well, an explanation in clear language of the principles on which the method of solution is founded. Speeds of drills, taps, and milling cutters, emery wheels and grindstones, figuring change gears for screw cutting on lathes, figuring size of drills for holes to be tapped, explanation of the metric system with convenient tables, principles of square and cube root—these are some of

the headings taken at random in turning through the book. The style is clear and instructive, and the book seems well calculated to achieve the purpose held in view by the authors. The index is full and well arranged for handy reference. The entire mechanical make-up of the book is excellent—paper, presswork, and binding—and it may be cordially recommended to those for whom it was intended.

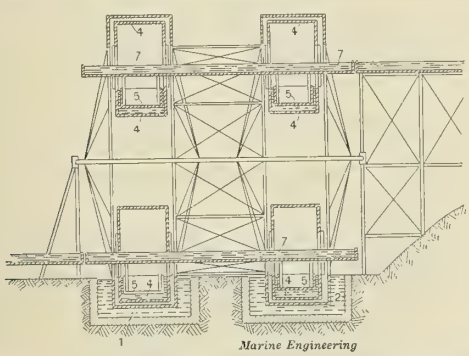
SELECTED MARINE PATENTS.

710,472. HOISTING APPARATUS FOR WRECKING VESSELS. SIMON LAKE, NEW YORK, N. Y. (No model.)



CLAIM.—1. The combination with a floating vessel, of a hoisting line, a sheave pulley suspended from a mast or spar upon said vessel, over which said hoisting line is led, a yielding device operatively connected with said line, a stop shoulder or detent for said yielding device, and means for yieldingly maintaining said device normally in engagement with said stop shoulder or detent in opposition to normal pulls upon said line, but permitting the same to recede from said stop shoulder or detent under a predetermined maximum pull upon said line. Twelve claims.

710,635. APPARATUS FOR RAISING OR LOWERING CANALBOATS, ETC. AUGUST UMLAUF, VIENNA, AUSTRIA-HUNGARY, ASSIGNOR TO FIRM OF VEREINIGTE MASCHINENFABRIK AUGSBURG UND MASCHINENBAUGESELLSCHAFT NURNBERG A. G., NUREMBERG, GERMANY.

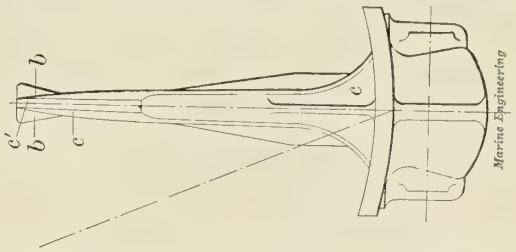


CLAIM.—1. A lifting or raising apparatus in which the water chamber for carrying the load itself is formed so as to float, comprising an annular vessel 1 floating in a basin 2, said vessel having pairs of fixed rolling drums 4 arranged diametrically opposite to one another and filled with water up to a suitable level, in which drums pontoons 5 carrying water chambers 7 float, so that the pontoons always stand horizontally and are raised or lowered on the rotation of the annular vessel 1. Two claims.

711,021. REVERSIBLE PROPELLER. STORER W. THAXTER, BANGOR, ME.

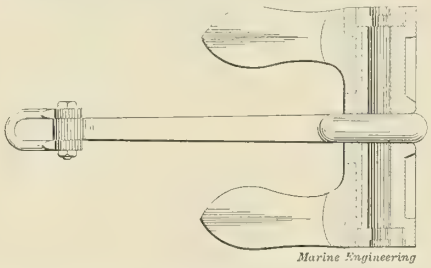
CLAIM.—1. In a reversible propeller the combination of two propeller blades having their shanks shaped and adapted to socket together in a bore in a block or bearing, each shank having an annular circumferential groove near the junction of the shank and blade; a block or bearing bored to receive said shanks of said blades and having two smaller bores at right angles to said first bore concentric with the grooves in said shanks, and two lockpins adapted to fit said two bores and said grooves. Two claims.

710,825. SHIP'S ANCHOR. WILLIAM W. WHITE, NEW YORK, N. Y., ANCILLARY EXECUTOR OF JOHN VERITY, DECEASED.



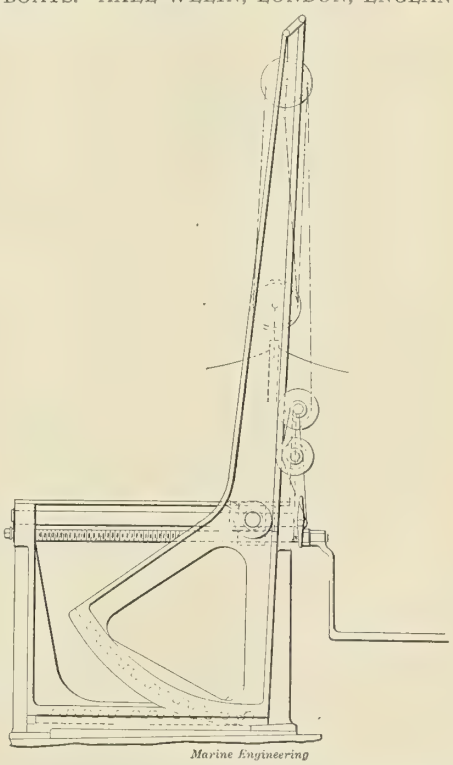
CLAIM.—In a ship's anchor of the kind herein referred to the flukes *c*, with heart-shaped fluke-tips *c'*, disposed in the general plane of said flukes, and projecting cuneiform ribs *b* on either side of the tips *c'*, said ribs forming a flat surface at the end of the fluke-tips *c'* and extending at each side at right angles to the plane of same, and tapering inward toward the surface of the tip. One claim.

710,918. ANCHOR. JAMES P. S. LAWRANCE, U. S. NAVY, ASSIGNOR OF ONE-HALF TO THOMAS BURD ZELL, CHESTER, PA.



CLAIM.—1. The combination in an anchor of the shank, a pair of flukes, a shaft or spindle formed integral with the shank and supporting the flukes, said flukes having hubs extending from the shank to the ends of the shafts and being permitted to oscillate with respect to the shank, means carried by said flukes and coacting with the shaft or spindle for limiting the movement of the flukes, and means for securing said flukes to the shafts or spindles, said flukes having recessed portions for the reception of the securing means. Four claims.

711,749. APPARATUS FOR RAISING OR LOWERING SHIPS' BOATS. AXEL WELIN, LONDON, ENGLAND.



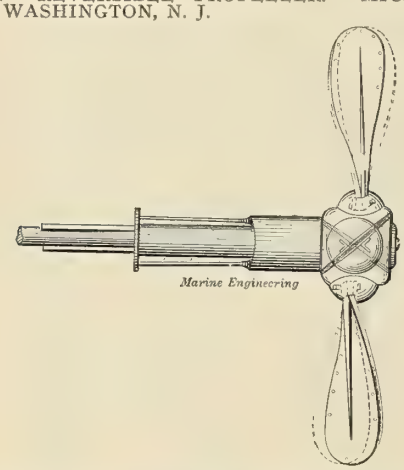
CLAIM.—1. The combination of a davit free to turn in a vertical plane, a pulley carried by its upper end, an attachment for carrying a boat, a rope passing over the pulley and supporting the attachment, a pulley fixed to the vessel around which the rope

passes, and means carried by the davit for drawing the rope over the pulleys as the davit moves outboard. Four claims.

711,884. STEERING PROPELLER. VICTOR SJOSTROM, LOS ANGELES, CAL.

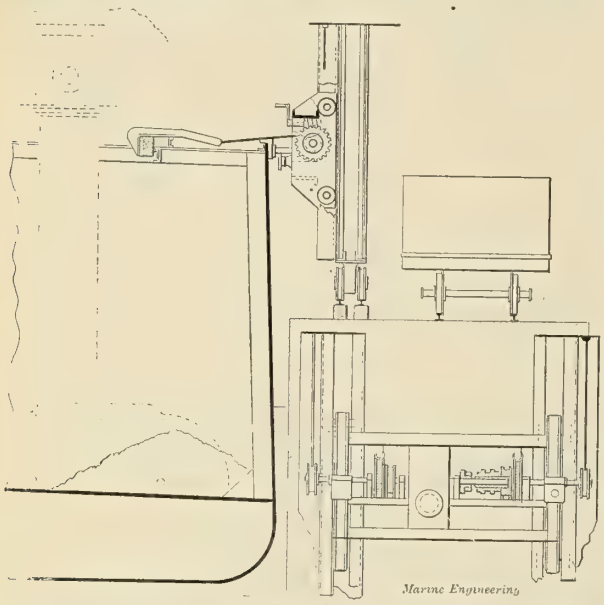
CLAIM.—1. The steering propeller consisting of a revolving cylindrical casing, the spiral blades within said casing, the outer pivotally-mounted cylindrical casing, the antifrictional rollers in recesses having inclined sides, the movable rings, the projecting rim on the outside of the cylindrical casing and the rings maintained at the requisite distance therefrom, the whole being attached to the stern of a ship and all operating in the manner and for the purposes substantially as hereinbefore set forth. Five claims.

712,123. REVERSIBLE PROPELLER. MICHAEL H. DEPUE, WASHINGTON, N. J.



CLAIM.—1. In a reversible propeller, the combination with a propeller shaft of reversible blades mounted thereon, and operating means for reversing some of the blades independently of the other blades, or all of the blades together, said means comprising a sectional sleeve, means for independently or jointly operating the parts of the sleeve, and connections between the parts of the sleeve and blades to oscillate said blades when said sleeve sections are operated, substantially as specified. Four claims.

712,215. VESSEL-HOLDING DEVICE. GEORGE E. TITCOMB, CLEVELAND, O.



CLAIM.—1. The combination with a ship-unloading apparatus having a leg movable parallel with the dock edge, of a vertically-movable clamp carried thereby and adapted to engage the ship and prevent it from moving toward or from the unloading apparatus, substantially as described.

2. The combination with a ship-unloading apparatus having a leg movable parallel with the dock edge, of a vertically-movable trolley carried thereby, a strut carried by said trolley and adapted to engage the side of a ship, and means carried by the trolley and adapted to engage the end of a hatch opening and hold the ship against said strut, substantially as described. Eighteen claims.

712,369. FLUID-PRESSURE TURBINE. HUGH F. FULLAGAR, NEWCASTLE-UPON-TYNE, ENGLAND.

Fourteen claims.

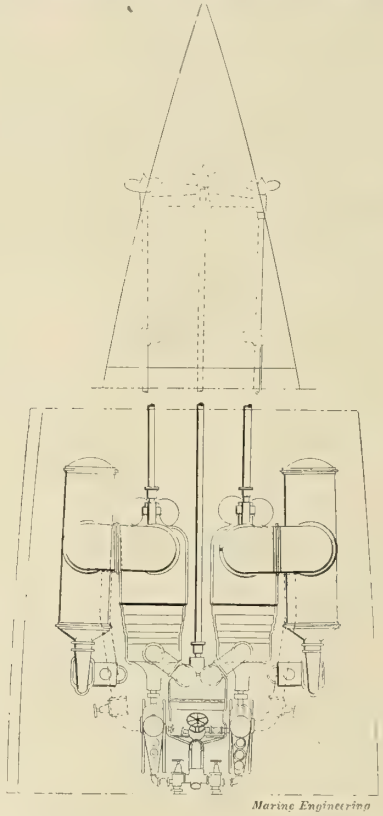
712,424. REVERSIBLE STEAM TURBINE. HENRY F. TYZACK, GATESHEAD, ENGLAND, ASSIGNOR OF TWO-THIRDS TO HENRY SHADFORTH SCOTT, GATESHEAD, ENGLAND, AND ISIDOR SUMMERFIELD, NEWCASTLE-UPON-TYNE, ENGLAND.

Three claims.

712,677. MARINE PROPULSION. ROBERT B. HEWSON, SAN FRANCISCO, CAL.

Six claims.

712,713. PROPULSION OF STEAM VESSELS. CHARLES A. PARSONS, NEWCASTLE-UPON-TYNE, ENGLAND.



CLAIM.—1. A system of engines for propelling steam vessels, comprising a reciprocating engine adapted to propel the vessel at cruising speeds, a turbine engine adapted to alone propel the vessel at full speed, shafting to which the engines are connected, and condenser means to produce condenser-vacuum, in which the turbine runs idly when the reciprocating engine is alone employed for propelling the vessel at cruising speeds, substantially as described. Seven claims.

712,814. BATTERY INSTALLATION FOR SUBMARINE BOATS. SIMON LAKE, BRIDGEPORT, CONN.

Nine claims.

Oil Fuel.—Oil has been adopted for fuel in both the Cramp shipyard at Philadelphia and the Townsend-Downey yard on Shooters Island. At the latter yard oil has been used in the plate furnaces for several months.

Coaling Warships.—The British Admiralty recently fitted out at Portsmouth a vessel to act as a floating coal depot. She was built with large hoppers, so arranged that coal might be withdrawn from the bottom. Owing to the weight of coal above the hoppers, the openings clogged up and were only cleared with difficulty. The Admiralty has brought out new designs, in which these difficulties have been overcome, and many firms have been asked to bid on two coaling vessels of 12,000 tons each. The hulls are divided into immense holds from the lower deck up. In the lower decks are chutes through which the coal falls by gravity into the bags fixed below. These bags are then conveyed to hoists in the central passage, raised and unloaded from the deck into the vessels alongside.